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The Cornell Dividing Engine—I.

BY GEO. F. BALLOU.

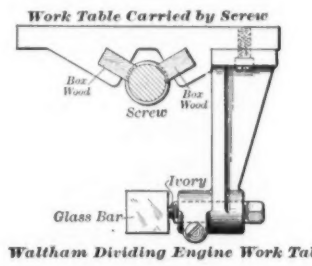
A "dividing engine" is a machine for making marks on any substance, such as a piece of glass or steel, all exactly the same distance apart. If a bar of steel was planed in a shaper vise, and then marked off with a tool held in the shaper tool post, one mark for one complete revolution of the feed screw of the shaper, then the bar would be "divided," and the shaper would have acted as a "dividing engine," and the division lines on the bar would be nearly enough correct, or nearly enough the same distance apart, to serve well for many machine shop purposes; and this function of making lines at equal distances apart is all that any dividing engine can do. This seems a very simple operation, and in reality it is a very simple operation, and yet the machine I shall describe can justly claim to be the most perfect machine for measuring lengths ever made in the world up to the date of its construction. I regard it with great pride for that reason, and because, including the patternmaking, it was all the work of my own hands, and was built in the short time of six months and two weeks. I always smile when I think of how that odd two weeks was spent, and how dreadfully I was worried all those fourteen days.

I am the more pleased with this Cornell dividing engine, because it was not only so perfect as to excel anything ever produced before in the way of accurately measuring and dividing inches, but was made after I had been trying in vain for nearly five years of steady, hard work to make a machine of its kind in which I could find no fault.

As might be expected of the first machine ever made in the world which could certainly divide an inch into a very great many perfectly equal parts, this machine has been described in many publications of high rank, and discussed before many societies of learned men; but the story of the actual machine shop doing of the work has never been told before, and that is what I shall tell here—just what I did, how and when, and why I did it, and why I could not do it for five years, in what was then, and perhaps is now, the shop best fitted for doing accurate work of any in the world—the Waltham Watch Factory, at Waltham, Mass., 10 miles from Boston. I had been a tool maker at the Waltham shops for several years before I began to work on the dividing engine. The Waltham Watch Company had an observatory of their own with some very good, steady running clocks in it, which I had built, and I was in charge of the time observations, which were made at Waltham, to obtain correct time by which to regulate the watches made there; and when Prof. W. A. Rogers, who was then Professor of Astronomy at the Cambridge Observatory of Harvard College, came to the Waltham shops to have a dividing engine built, I was detailed by Supt. Chas. Vanderwoerd, superintendent of the Waltham factory, to do the work for Professor Rogers. Mr. Vanderwoerd was a Hollander, an extremely good mechanic, who made a great many excellent improvements in watch machinery, and in methods of watch part making. He was not only a very fine and original mechanic, he was also a very stubborn man; when he had once decided on doing a thing a certain way, it took more than a trifle to make him change his mind; he was generally right, and proved himself so in the end; when he was not right the lesson had to be fully learned before he would admit its truth. When Professor Rogers, whose name has long since become identified with accurate measurements, came to the Waltham shops to have a dividing engine built, he had only a general idea of what he intended to make, and no idea at all of what obstacles lay in the way of making such a machine; nor had the Waltham Company any knowledge of the matter. There was at that time a piece of metal in the Tower at London with two marks on it exactly three feet apart, and this distance so measured on that bar was the only real standard of measurement for the English inch-using world. I do not know that that yard had at that time ever been divided into 36 equal parts, each exactly one inch long. It is certain that no screw of considerable length had ever been made which was of the same pitch or distance between two threads for its whole length, and I am also pretty sure that the screw of considerable length which was nearest like itself everywhere, was, up to that time, made by the Putnam Machine Company, with whose lathes and planers many of the readers of the AMERICAN MACHINIST are well acquainted. Whitworth, of England, was supposed to make accurate, evenly spaced screws, but such was not the case, and perhaps the nearest approach to an accurate 12-inch or one-foot measure was the Darling, Brown & Sharpe steel scale, which was, and is to-day, graduated or divided on a machine or "engine," the construction of which has been kept a secret from the day it was made until now. I have reason to believe, however, from a remark made by a person who does know the construction of that machine, that even division is effected by one of the methods to which I shall refer later.

As I have said, no one knew what troubles lay in the way of the dividing engine; Professor Rogers was much interested in the production of what are called "Nobert's bands," groups of lines ruled close to each other on glass, and all exactly the same distance apart. He also wanted to have a sure means of making scales and screws of exactly given lengths, measured by the British Imperial yard in the Tower of London, a copy of which, at Washington, is also our own American standard of length; and the Waltham Company, which had already a world-wide reputation for accurate work, thought it would like to have its name associated with the production of a machine, of such precision as the dividing engine was to be, and so, as I have said, I was detailed to go to work on this job, and began on a Friday, February 15, 1878.

Before this time Superintendent Vanderwoerd and Professor Rogers and a draftsman had in consultation made drawings of the new dividing engine which was to be in the general form of a shaper. The tool was to have two motions—one back and forth to make the line, and a trip motion to lift the tool off the work during its back stroke. The work table, like a shaper knee, was to travel along by the action of the screw to move the work just the right distance at each double stroke of the tool slide. This was the plan of the first machine, the one built at the Waltham watch shops, which I will call the Waltham machine. This machine never had a very good screw, although it was the best we could make, and is not the Cornell dividing engine. I shall call the Cornell machine the "Rogers-Ballou dividing engine." It was built in Boston at 35 Sudbury street, and was begun in January, 1883, nearly five years later, immediately after I left the Waltham shops.



Waltham Dividing Engine Work Table Support

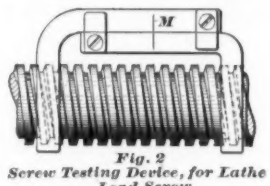


Fig. 2
Screw Testing Device, for Lathe Lead Screw

20 p.i. Clearing Tool $\frac{2}{100}$ wide

Fig. 3. Section of Finished Screw

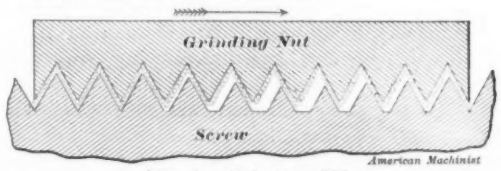


Fig. 8. Grinding Effect

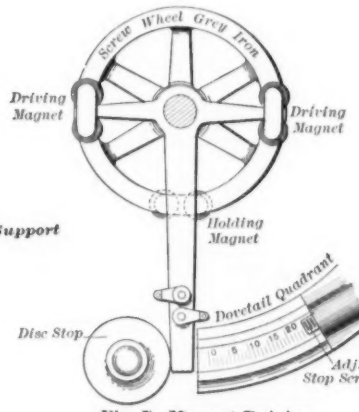


Fig. 7.—Magnet Driving and Holding

No. 6.
Diamond Holder

THE CORNELL DIVIDING ENGINE.

Professor Rogers was, when we began, Professor of Astronomy, located at the Cambridge Observatory of the Harvard College, three miles from Boston, and within easy reach of Waltham. He was very intimately acquainted with Mr. Alvan Clark, the great telescope maker, and a part of the Waltham dividing engine was made by Mr. Clark—a square glass bar to keep the work table from turning over with the feed screw.

The general construction of this work table is shown in the first sketch which I make from memory. The work table was not only moved along by the feed screw, but was carried directly on the feed screw; the "nut," or part which fitted the thread of the lead screw, was composed of two pieces of wood; various woods were tried, and I think box-wood was finally thought the best, and retained. These two strips of wood were located about 120 degrees of the feed screw circumference apart, in seats cut in projections on the under side of the work table, all as shown in Fig. 1. To keep the table from turning round with the screw an arm was fastened to the under side of the table and carried down some distance below the screw, and the lower end of this arm was tapped and split on one side and furnished with a pinching screw to take and keep an ivory-tipped adjusting screw. This ivory tip rested against the back side of a horizontal glass bar, $1\frac{1}{4}$ inches square, which reached across the machine; the feed screw was $1\frac{1}{2}$ inches diameter, and we made more than one of these screws; some 10 per inch, some 20 per inch, as we went along with the work of trying to make a truly pitched screw; that is, a screw which has all of its threads just the same distance apart. That was the thing which I tried so long to do at Waltham, and never could do perfectly. After we had been at work about two years, I think, we tried to do some work with the best screw we had made up to that time, but found it not good enough to give satisfaction; so we went on and on, and on, all the time following the same general plan of trying to correct the errors in the screws we made by grinding.

As I said, Superintendent Vanderwoerd was a very determined man; he had made up his mind that variations in the distances between the threads of the screws could be corrected by grinding the screws with nuts of soft metal charged with fine emery, and I spent nearly five years in this work before we finally came to a standstill, because the result was always the same. No matter what we did or how we did it, when we brought the screw to a uniform diameter, as we, of course, had to do for the final operation on each of the many screws I made in that five years, the old original error was always present at the end of the job. This was very discouraging, and after a few trials I lost confidence in the correction-by-grinding method, and grew very tired of the operation. Mr. Vanderwoerd's constant remark was "It will come right if you keep on grinding long enough," and I ground one screw down almost a sixteenth of an inch in diameter; this was a very slow operation; the speed had to be slow and the pressure light, and the work flooded with oil to avoid heating the screw. Once in a while we measured the screw and found the errors unchanged. Indeed, grinding did not seem to

change the screw at all, except to reduce the diameter. The screw stayed round, the threads kept their shape and were sharp on top, and the screw looked like the finest job ever made at the end of this long grinding, which did no good whatever. Mr. Vanderwoerd never lost faith in the method, and so I kept on, making some small change at each trial, but keeping to the same idea of correction-by-grinding, until at the end of nearly five years we worked the job to a standstill, with everybody dissatisfied, and nothing but failures behind us. I went to work on other things for a few months, and then the matter was brought to a conclusion with the Waltham Company, and Professor Rogers took the machine away with him.

At this time an unfortunate affair, for which I was not to blame, ended good feeling between Superintendent Vanderwoerd and myself. As soon as the Waltham dividing engine was laid aside I made three astronomical clocks—one for the Signal Service Office, Washington; one for Wesleyan University, Middletown, Conn.; one to be kept at Waltham, and went to Washington with the signal service clock.

While I was away a Waltham newspaper published a highly laudatory notice of these clocks, obtaining its information from one of the foremen in the Waltham shops, and giving me all of the credit. I think Superintendent Vanderwoerd was not mentioned at all in this article, which was very unjust as he designed the clocks wholly, and I had only built them. On my return from Washington, after setting up the clock, Mr. Vanderwoerd was at Montreal, attending a meeting of the American Association for the advancement of science, of which Mr. Vanderwoerd and myself were both members. Mr. Robbins, treasurer of the Waltham Company, told me Mr. Vanderwoerd was very angry over the newspaper article, which he attributed to me, and told me to go to Montreal and see Mr. Vanderwoerd and explain matters to him. I went and met Mr. Vanderwoerd in the corridor of the Windsor Hotel. He was very indignant, but finally seemed to understand that I had nothing to do with the clock article, and said that he thought I ought to publish a correction in the same paper. I told him I would do so, and sent a suitable account of the clock construction to the editor, giving Mr. Vanderwoerd full credit for the design of the clocks, and immediately after returned to Washington to make a series of tests on the new clock there, expecting the correction to appear at once. Instead of printing it, however, the editor submitted it to the same foreman who had given him his first information about the clocks, and this man very injudiciously told him that the first article put the credit where it belonged, and that my correction was simply policy to soothe Mr. Vanderwoerd, and in consequence the correction did not appear at any time, as its day had gone by when I returned, and Mr. Vanderwoerd, believing that I had intentionally trifled with him, was beyond conciliation, very greatly to my regret.

I speak of this matter here because I have never since, until now, had an opportunity to set myself right in this matter in a public manner, and have been blamed for what I never did.

Naturally, I had become very well acquainted with Professor Rogers during this five years of trying to make a perfect screw, and we had had a great deal of talk about different ways to produce such a screw, and believed that some one of the methods we had discussed could be made successful. It also seemed that there should be a constant demand for such screws from manufacturers of machine tools; even if manufacturers did not want to put perfect screws in all of their tools they would still, we thought, want several each to cut other accurate screws by. There was also accurate dividing to be done in the way of ruling Nobert's bands and "diffraction plates," which are used instead of prisms in the spectroscope, and altogether it looked as if there was a nice business to be built up out of the "true screw," which had never yet been made, but which we thought could be made. Behind all this both Professor Rogers and myself felt that although we had been able to do good work with the screws, and had probably made better screws than were ever made before, we had still failed to make so good a screw as we intended to make when we began, and neither of us felt like acknowledging ourselves finally beaten. So Professor Rogers proposed to me that I should leave Waltham and go with him into a shop which he would fit up in Boston, and there continue our efforts; this was done, and it was in the Boston shop that the Cornell dividing engine was built at the first trial with a degree of accuracy surpassing by far any piece of work of its size previously produced.

Failures are the instructive and the interesting things of life; they are not so agreeable as successes, but they teach us valuable lessons, and before going over the successful methods of the Boston shop, I will detail what we did at Waltham.

It is not necessary to have a perfect screw in order to make a nut traveling on the screw move a fixed distance for equal arcs of screw rotation, because the nut itself may be revolved, at the same time the screw is turned, some small distance which will exactly correct the faults of the screw; if the nut is turned the same way the screw is turned then the nut travel will be shortened; if it is turned in a direction opposite to that in which the screw is moved, then the nut will travel farther than the screw rotation would cause it to move. Or, again, faults in the screw might be exactly measured and the successive movements of the screw might be varied so as to make each impulse give the same length of travel to the nut. But both of these methods are plainly inferior to the use of a perfect screw, or one so nearly perfect as to be right in itself, and so in no need of modifying elements to correct its travels. Professor Rogers intended to make the screw perfect and so avoid the difficult and delicate work needed to make an irregular screw give a regular motion to the slide, and this was finally done, though not until a long time after it was expected to be done. Then, after a perfect screw, comes the means to move that screw just such a part of a turn every time as would make the screw thread carry the tool-slide a certain exact distance each time the screw was moved, and this is also a very difficult thing to do.

It was this part of the machine, the screw moving part, to which Professor Rogers had given most thought; and as it proved, the way he had devised was perfectly good. All machinists know something about the difficulties of dividing a wheel edge into perfectly even teeth; this is very hard indeed to do when absolute accuracy is demanded. It is quite easy to cut teeth in a wheel which will vary only a little in spacing, say one-thousandth of an inch, but it is very difficult to divide a wheel into teeth spaced so nearly alike that tests made with a microscope will not detect any difference whatever in the teeth. And there is another objection besides the unevenness of the teeth to moving the screw of a dividing engine by means of a toothed wheel or ratchet. Professor Rogers wished to rule lines any distance apart; this would make it needful with a toothed wheel for moving the screw, to introduce change gearing between the toothed wheel or ratchet wheel and the screw, so that the screw could be moved any part whatever of a revolution instead of some unchangeable part of a revolution, as it would have to be if moved by a toothed wheel directly; and the change gears would also have to be spaced exactly in the teeth or else there would certainly be differences in the distances the screw was moved at successive impulses. In fact, every piece put into this screw-moving part of the machine must of necessity be a possible source of error in the screw action. But suppose a perfect screw, straight, and having all of its threads exactly the same distance apart, has a smooth true wheel fastened on one end, and that there is also an arm pivoted on the screw so that it can swing back and forth on the screw as an axis; and suppose this arm could be made to take hold of the wheel on the screw at any time and at any place on the wheel, and some other part which could not move in either direction of wheel revolution, could take hold of the wheel and hold it tight at any time, and that both the swinging arm and the wheel on the screw could be released at any time, and that the swinging arm could be given unvarying arcs of travel, then there might be a reasonable expectation of moving the screw any part of a revolution any desired number of times without variation. This was what Professor Rogers had designed to do, using electro magnets fastened to the frame of the machine to hold the wheel still, and electro magnets carried by the swinging arm to fasten the arm and wheel together, and making and breaking the contacts which made these electro magnets take hold and let go by a cam action, and moving the arm by such means as would carry it exactly so far and no farther and start and stop it without any jar. This could all be done quite easily with electro magnets to do the holding, as sketched in Fig. 7. To hold the wheel still, a magnet can be bolted tight to the frame, and the screw wheel fitted so it will barely run free past it when it is not connected with the current, and when connected so as to make it a magnet it will grasp the wheel and hold it very firmly indeed, and this holding and releasing can be effected by making and breaking the contact, with the screw moving wheel in any position whatever, the wheel of course acting as the armature. The same way with the grasping and releasing magnets carried by the swinging arm; they could be made to take hold and let go of the wheel at any point and at any time, as governed by the cam making and breaking the electrical contact.

It is also easy to cut a fine line in glass or steel with a diamond point or edge. Diamonds have a grain, or a direction in which they will split easily, just the same as a piece of wood has; an expert can tell by looking at a diamond which way it will split, and the first operation in cutting a rough diamond into the finished gem is to split pieces off the outside of it to bring it to something like its final shape before beginning to grind it, and these chips so split off are used for a great many purposes in the arts. It is of these chips that the marking tools for the dividing engine are made. A chip is selected which is tapering in outline, and convex on one side. This convex or rounding side is left as it is, with its natural outside unfractured surface, and the other side is ground down flat and polished, so that when the crescent edge is examined with a low power glass it looks to be a perfectly smooth curved line; but if examined with a higher magnifying power the edge is seen to be full of little teeth, and any one of these teeth may make a very enduring tool to mark lines with on either glass or metal. It does not do at all to grind both sides of the diamond chip down to a smooth surface; to make a good marking tool, one surface must be left as it stood on the stone, of which it originally formed a part, while the cleavage surface must be ground and polished to a fine lustre. Sometimes this diamond marking tool can be set in the tool holder, Fig. 6, the first time trying so it will mark a perfectly smooth deep line, and sometimes it takes hours of trial to find the one particular little tooth on the crescent which will make a good line; sometimes the diamond cuts a beautiful little spiral chip, just like a lathe or planer tool; sometimes it takes out a straight chip with no curl in it, and some diamond cuts do not make any chip at all that can be discovered, and any diamond marking tool may last a very long time, or it may break short off at once, or in a little while; and then it has to be set over again by trial to a point where another tooth will come into action.

It was, of course, necessary that the machine should be very well built. All of the moving parts had to be fitted so that there was no lost motion, and, at the same time, so there would be sufficient freedom of action.

But these things gave little trouble. The Waltham shops had every facility for making accurate work, and it was only when I began to look for a perfect screw that real trouble came. It was not necessary to produce a screw which had exactly an even number of turns to an inch or a foot, but it was very desirable that each thread of the screw should be exactly the same distance from the one next to it, and I began a search in the shop for a lathe with a lead screw good enough for cutting the dividing engine screw. It was soon found that there was no lead screw in the Waltham shops anywhere near perfection.

To test the screws two pieces of square stock were bent at right angles, and carefully fitted to the screw threads at the short ends so that their long ends would lap each other, and these lapping ends had clips screwed on them all, as shown in Fig. 2. Then, with the short fitted ends in place between the screw threads, a line was drawn across the two ends which lapped each other. To use this tool it was only needful to put the two short ends into the screw threads; so long as the index marks *M*, Fig. 2, on the long ends of the bars exactly coincided, the pitch did not vary, but as soon as the turning of the screw caused the lines to break with each other, it was certain that the pitch varied. Simple and rough as this test may seem, there was no lathe lead screw in the Waltham shops in which it failed to show errors. In some screws the errors were short, the lines passing and repassing each other often; in other screws the waves of variation were long, and the index lines would vary slowly from one side to the other. I finally selected a Putnam lathe as having the least imperfections in its screw, and began work. The selected lathe was taken into the basement and carefully leveled on the concrete floor. Everything was stripped off the bed, and the whole of the fitting was carefully examined, and every fault, no matter how small, was made good, so we could know that whatever faults appeared in the work were due to errors in the lead screw itself, and not to defects in any other part of the lathe. As the change gears were not to be moved on this job, it was not needful to correct errors which they might contain; the screw itself had errors which made any minute errors due to faulty tooth spacing in the change gears unimportant so long as the change gears were not to be moved. The concrete floor of the basement could be relied upon as unchanging, and the basement temperature was so nearly uniform as to need no especial regulation in the room partitioned off for work on the "true screw." The stock was Jessop tool steel, octagon, unannealed, just as it was cut off the bar. The finished diameter of the screw was to be 1½ inches. The stock was not annealed, as it was thought best to have the screw as hard as possible, and it was also thought that there would be less trouble from springing of the blank, as successive cuts were taken off, if the stock was used as it came, without annealing. There was never at any time any trouble from the springing of the blank.

The stock was first centered as usual, and roughed up on the centers. Then a bell chuck center was put in the live spindle, and one end of the screw blank very carefully fitted to this bell chuck, which then served as a driver, so that there was no side twist or out of balance due to the use of a driving dog. Then the blank was turned very carefully to size, and threaded with a 60-degree V-tool, and afterward cleared at the bottom, as shown in Fig. 3. Then the new screw was tested in the same manner as shown in Fig. 2, and found to be full of errors, same as the lead screw was. There were no special devices used to regulate the temperature of the screw while it was being cut.

When it is said that this screw was full of errors, it must not be understood that these errors were visible to the eye; the job appeared perfect, and was as good a screw as could be cut in any lathe in the Waltham shops at that time. All of the errors were extremely small, and we all thought that if two half nuts of lead or babbitt were made

in cast-iron shells, and fastened together and run over the thread for a while with oil and emery, then the long and short places would become uniform. The first result with the first nut, and a great deal of care and oil, and emery, and reversing of the lathe, and running backward and forward, and testing the new screw to find out what we were accomplishing, showed a grand final total of no effect whatever, just a simple zero. At the end of it all the screw was just where it was when the cutting tool left it. It was very bright and smooth, a little smaller in diameter, the threads beautifully sharp and unchanged in shape, and the errors, as nearly as we could determine, all safe and secure right where they were when the grinding began.

We tried grinding with short nuts, and nuts a little longer, and nuts as long as the screw; nuts reversed, nuts cast, and nuts cut in the lathe; lead nuts, brass nuts, everything and every variation we could think of, with the same invariable result. It does not seem possible that we could have used nearly five years in this one experiment, yet, in fact, we did do precisely that. There may have been in all a year consumed in the perfection of the other details, and perhaps another year used in talk and consultation and debate, and in trials of the screws, but the one job was screw grinding to try to grind the errors out. Superintendent Vanderwoerd was sure that the errors would come out, but they never did.

After we had all had enough, and a great deal too much, for that matter, of power grinding in the lathe, we took a screw to the vise, and stood it up on end; after we had measured it all over, and marked the long and short places, we took a short nut and ground the thread with the screw standing up, putting on a hand pressure to take off stock on the side of the thread which would correct the error, turning the screw the other end up when it was needful so as to grind the top side of the thread always. By this vertical hand grinding we really succeeded in bringing the screw very near indeed to a uniform pitch, but it then did not have a uniform diameter, so we took it back to the lathe again, and put on a brass grinding nut cut in the lathe, and started in with the oil and emery and abounding patience to grind the screw to a uniform diameter. When this was finally done, and the screw was one size from end to end, we had all the old original errors right back home again, just the same as they were at first. The explanation was simple enough. When we corrected the pitch by the vertical grinding, we took the stock off one side of the thread, and made the corrected threads low; when we ground down to the small diameter the whole of the hand grinding was eliminated—nothing of it left, and the errors right where they had been all of the time.

The large scale sketch, Fig. 8, "grinding effect," shows very clearly why we could not grind a screw to an even pitch and uniform diameter after we had corrected it by hand grinding on the sides of the thread in the vise, so that the screw gave a uniform nut travel for each revolution. In Fig. 8 the small circles represent the emery; it will be observed that in some places there is no abutment or opposing surface to cause the emery to grind the screw for a considerable distance. The result of this changing abutment is to so distribute the grinding effect as to cause the original errors of the thread, eliminated by hand grinding, to return when the screw is ground to a uniform diameter.

Here we were at the end of the five years. Professor Rogers with all his mathematical genius, Superintendent Vanderwoerd with all his experience in the finest and most skillfully contrived mechanism the world ever saw, and I, myself, with, as I thought then and know now, a practical knowledge of machine work sufficient to execute any job with all the precision attainable by hand work, all of us baffled, beaten, overthrown, conquered and disgraced by the persistent errors in that miserable little soft steel screw, 24 inches long and an inch and a half in diameter!

And that was the end of the Waltham dividing engine. There had been many a heated argument, many a flat disagreement between Professor Rogers and Superintendent Vanderwoerd, and I, though I was there to take orders, and took them, too, I obeyed them as many a workman had obeyed orders before—with a full conviction that my best efforts would only result in failure on the lines ordered.

Mr. G. C. Henning, under the head of a "Paradox in Hydraulics," writes in the AMERICAN MACHINIST of continuous flow pumps, a subject presented last year by the editor of *Industry* before the Technical Society of the Pacific Coast. Mr. Henning constructed a continuous flow pump, and found the discharge equal to more than double the theoretical displacement. He also analyzes the forces, and sets forth both graphically and by formulæ the particular conditions of such pumping, and for the higher speeds sets down a discharge of more than 90 per cent. over the displacement of the pump. Except a very few, no one seemed to understand the import of the paper above referred to. It is published in No. 60 of *Industry*, and now seems likely to bear fruit. Some experiments are about to be made here by a well-known engineer that will, no doubt, confirm Mr. Henning's results.—*Industry*.

A significant and gratifying fact, as showing something of the condition of the tool business, is that The Pratt & Whitney Co. have now 840 men at work, which is very nearly their full complement, and 140 more than were employed a month ago.

Doings at Backaway.

SMEATON REDUCES WAGES.

Mr. Editor—I have thought for some time that you might be interested in Smeaton's experience in cutting wages in the mills, but somehow could never seem to get at the way of telling the story. It was like this:

About six months after this little weariness in business struck the country, Smeaton sent for all the heads of departments to meet him in his office. Every mill in Backaway, and round about, had made rather discouraging reductions in wages, followed by strikes, suspension of work, failures and the like, including general dissatisfaction, and I don't suppose there was a man of us that went to Smeaton's office that did not expect to hear that wages were to be reduced at the G. & I.

Smeaton began without delay—never lost much time in preliminaries, Smeaton didn't—by saying: "Gentlemen, I have got to make a reduction in the cost of the product down to this: I've got to turn in more money to the stockholders, or quit and let someone else try his hand at it. That's just the way it stands.

"Now," continued Smeaton, "I have no doubt you have all thought this over—thought it over more or to better purpose than I have, and what I have asked you to meet me for is to get the benefit of your views."

Did you ever notice, Mr. Editor, that you can never take a man quite so completely by surprise as by bringing him face to face with what he expects? I believe this is true, and that it accounts for the silence that followed Smeaton's remarks.

No one was inclined to say anything, until finally Smeaton appealed to Archer. Archer is the oldest foreman in the mills—got over any suspicion of hot-headedness or anything of that kind—and we were all glad that he was to have his little say.

"Mr. Smeaton," said he, "everyone in these mills, and in the whole village, knows that the G. & I. has been paying big dividends for the past ten years. In all that time you couldn't have bought a share of the stock short of paying three to one for it. But those big dividends that have been paid don't count with the stockholders now"——

"That's the water that's gone by the mill," interrupted Smeaton.

"That's it, exactly," continued Archer, "and the water that's gone by the mill does no more grinding, not in that mill, anyhow. The only question in my mind is whether so much water should have gone by. I sometimes blame stockholders for not letting good times and bad times offset a little more in the workingman's favor. I *think* that's what I'd do, but I don't know. Perhaps if I was a stockholder in the G. & I. I shouldn't feel like putting my hand in my pocket to tide over bad times for a couple of years. Perhaps I should want to stick to what I had made, and pay less wages when the profits began to decrease. That's human nature, and human nature is pretty much alike all around. No man can tell what he'll do till he comes right to it.

"By the way," Archer went on, "did the president say anything about reducing the rent of the company's tenants, or reducing the price of board in their boarding houses?"

Smeaton isn't given to getting rattled, but you could see with your eyes shut that he was taken just a little aback as he answered "no."

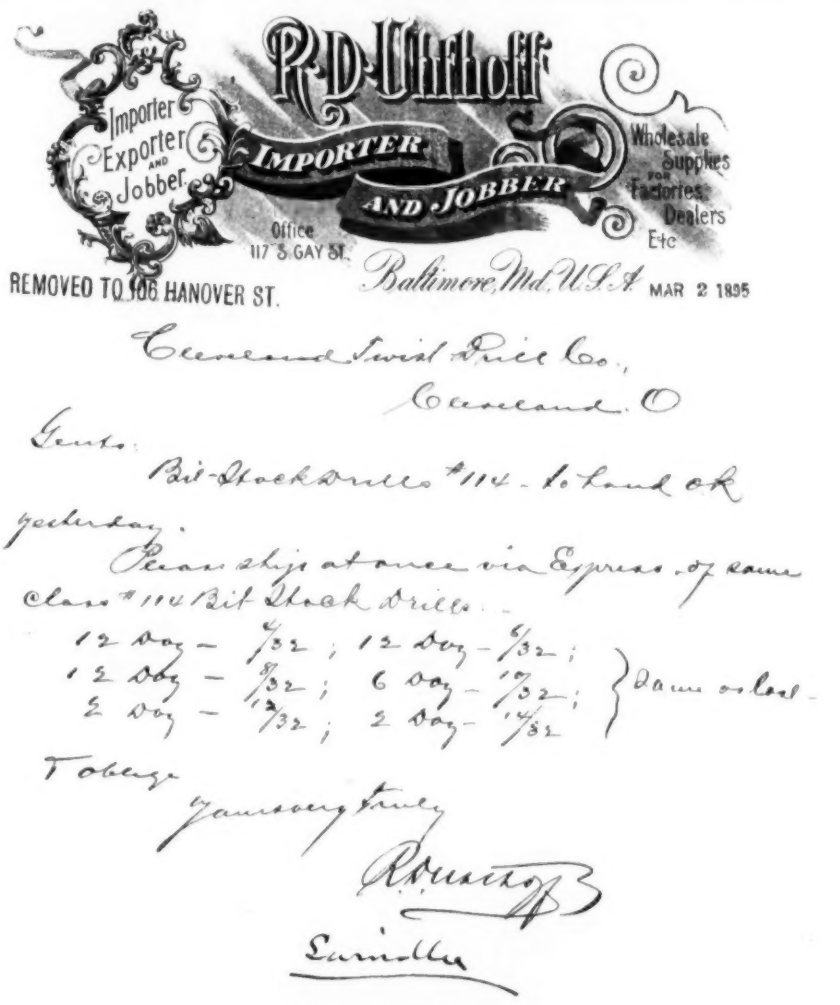
"But," said Smeaton, "what in your opinion would be the result of lowering wages?"

"I suppose," Archer replied, "that the men would stand the reduction because of necessity. If they have to pay the company the same rent, or the same price for board as now, they will think it is a case of both boots on one leg. In any event, unless the men are satisfied that there is an actual necessity for a cut in wages, there will be discontent, and the quality of the work will suffer. I've had fifty years' experience in mill work, and I never knew this fail. Directors and stockholders always have made the mistake, and I suppose always will, of believing that none of the men who look just like a part of the machine they are tending, can do just as good a job of thinking as they themselves can do. That's a bad mistake to make."

Archer sat down, and Smeaton sat thinking for fully five minutes, then he said: "It's only fair to the directors to state that they do not ask the men to stand all the loss from hard times, they only ask that the loss be divided."

It was Archer's turn to interrupt, which he did by remarking that he supposed Mr. Smeaton meant failure to make as much money as usual when he referred to the loss of the company.

Smeaton took the interruption good-naturedly, and continued: "I believe in straightforward talk in this matter, and, anyhow, you all know the result of cutting wages in other mills around us as well as I do. It's common talk all over town that the Upper Ford mills had a fifty-thousand-dollar consignment returned less than a month ago because the of these mills. I've been thinking it over since I had a hint to that effect from the president, a week ago, and last night he told me that at a special meeting of the directors that day they had decided that there was no way out of it but a cut of ten per cent. all around. The company couldn't sell goods, he said, at a loss, or at least the stockholders wouldn't submit to it, and the men must work for less money. The directors, he said, expected me to reduce wages, but wanted it done quietly; didn't want a strike or anything of that sort that would injure the reputation of the mills, and they depended upon me to get along without trouble. The fact comes right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} Same on hand.
Yours very truly
Swindle

A Swindler's Order.

Last week we published a letter from the Cleveland Twist Drill Company, exposing the swindling methods of R. D. Uhthoff, of Baltimore. At our request, the Cleveland Twist Drill Company has kindly forwarded to us an original order received by them from Uhthoff, and we publish a fac-simile reproduction of it reduced about one-third. The word swindler written at the bottom (in red ink in the original) was, we presume, added to it in Cleveland. This order was not filled, and part of the goods sent on a previous order were recovered by process of law. We take the trouble to print the above fac-simile in order to attract attention to this swindler, and make it unnecessary for any of our friends to get caught by him. At the same time, it is well to remember that new letter heads are easily and quickly obtainable, and that other names can be used. In fact, we are advised that there are several members of the gang, and the moral seems to be not to be impressed by attractive letter heads, but to take the trouble to be assured of the good standing of new customers, or ask them to pay spot cash.

goods were not up to standard, and this in spite of an inspection service which they claim is the best in the world, but, mind you, the cut in that mill was twenty-five instead of ten per cent. And you know the condition of other mills where big reductions in wages have been made. To be perfectly frank with you, as I promised in the beginning, if it should come that the G. & I. is beset by such a state of affairs as that at the Upper Ford, I'll let someone else try it. I've seen enough of it in my life, and if I can't have men with me who are reasonably well satisfied, I will not have any.

"But it will not come to that if we all work in harmony to prevent it. Let us see how we can make it different. Mr. Oldone, how closely will your engine regulate the speed?"

I explained to him that Jim had instructions to keep steam at one hundred pounds, and that he kept the pointer right there—just as still as if it was glued to the gauge dial, that the same grade of oil was used right along and that the work in the mills was practically constant from morning till night. With these favorable conditions, and the excellent governor on the engine, I had never known the speed to vary so much as one per cent. during working hours.

"Close regulation," said Smeaton. "You remember when we put in the engine we concluded it might, sometimes, run as much as six per cent. over-speed, and that would do a good deal of damage to goods in process of manufacture, so we speeded the machinery accordingly. It was an outrageously large allowance to make, but that doesn't change the fact that we made it. Now, if the engine never runs more than one per cent. fast it can be safely speeded up four per cent., and still have one per cent. to spare. Am I right in this?"

I couldn't see where he was wrong, so I agreed he was right, all the while kicking myself because I hadn't thought of it before. I thought I could see something of what Smeaton was driving at, but I could only see four per cent., which was a good ways from ten. But he wasn't through yet. He continued: "We all know the improvements Mr. Oldone has made in the machines during the past three years.* He has had a good-sized machine shop in operation during that time, and only day before yesterday told me he had everything completed. Now, in my opinion, there isn't a machine in the mills that will not stand speeding up considerably. In other words, I think that with the higher safe speed incident to the close regulation, and the safe increase that will be due to the improvements I have spoken of, we can speed up ten per cent. without danger. Mr. Oldone will have to decide whether he will change the speed of the engine, or put a new pulley on the jack shaft.

"This ten per cent. is exactly the reduction proposed by the directors. Now, with a ten per cent. reduction per piece and an increase of ten per cent. in speed, the pieceworkers will get the same money as ever Saturday afternoons—or if none of you can see more objections than I can, we will make the increase in speed eleven per cent., the extra one per cent. being for the purpose of covering contingencies. As for such day workers as don't run machines—there are only a few of them anyhow—I am firm in the belief that there are mighty few men who cannot, in one way or another, make their work count for ten per cent. more to their employers. They can do a little more thinking, that will make their efforts tell better, and a little more saving here and there, to help along. A man can make this ten per cent. up and never be able to tell you how he does it, and I don't believe there is a man in these mills that will not do it if he is approached in the right way; approached with honest argument of the necessity, and not in a stand-and-deliver manner.

"Now," said Smeaton, "what do you think of this plan of reducing wages, that gives the men the same money as ever Saturday afternoon, and at the same time helps the stockholders out? If any one of you cannot see his way clear to making this work in his department, this is the time to mention it."

There wasn't any objection to Smeaton's plan. If there is one thing that department foremen in a mill dread more than another, it is being obliged to get out good work—or the best they can—with men who are not satisfied with the way they are being treated.

"I do not want," Smeaton said, "to be obliged to let a man go on account of dull times. The men need the work, and the company ought to need it, and I think will. This company has always paid good wages, and has made money by doing it; good men have been kept right along, year after year, and this more than any other single thing has made the reputation of the mills.

"All this I shall lay before the directors, as soon as you assure me that your men will enter heartily into the plan. The proposition will be, to repeat it so that there will be no misunderstanding, that we get the goods out at ten per cent. less than the present cost, keeping the Saturday afternoon pay to the men the same as at present. I have no doubt the directors will gladly agree to this, and I have even less doubt that we can fulfill our part of the agreement, if all the men in the mills work together to that end. I believe they will all do this, because of the policy pursued here of employing none but intelligent, reasoning men, men who don't sign their names with the letter X. I expect that we shall a little more than make up the ten per cent. to the stockholders, and that if there is any change in the quality of the products of the mills it will be for the better."

Smeaton was right. There wasn't a dissenting voice amongst the directors or the men. Even Jim, whose settled aversion to wearing out the plank by wheeling so much coal up the incline, I have told you about, allowed he wouldn't mind a few more barrows a day, but added that when he got his scheme for making less carbonic oxide in the furnaces working all right, more coal wouldn't be needed.

Smeaton's plan for reducing wages has been in operation more than a year. I don't know how the stockholders have fared, but I do know there has been no further talk of reducing wages, which is a pretty sure sign that they are not suffering. The men are making just as much money as ever—some of the pieceworkers a little more. There are more men working in the mill to-day than ever before, and I heard Smeaton telling his new assistant super that the quality of the output had never been quite so good, and that this had stimulated foreign trade till he hardly knew which way to turn to fill orders.

The G. & I. mills are the only ones in this part of the country running full-handed, full time or full pay, and Archer says it's all owing to Smeaton's plan of co-operation. That's what Archer calls it, co-operation.

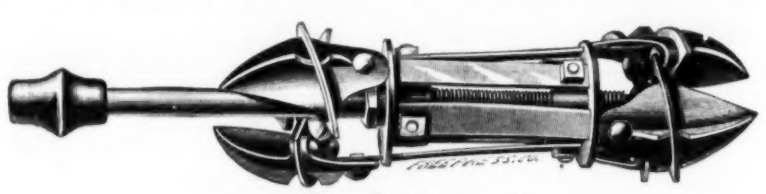
Very truly,
Joel Oldone.

*It is one of Smeaton's pet weaknesses to lay every improvement around the mills to someone else. He had suggested nine-tenths of the plans for improving the machines, and I had simply worked out the details.

A New Flue Scraper.

The accompanying cut illustrates the King adjustable flue scraper.

In this scraper the hardened steel knives



Flue Scraper.

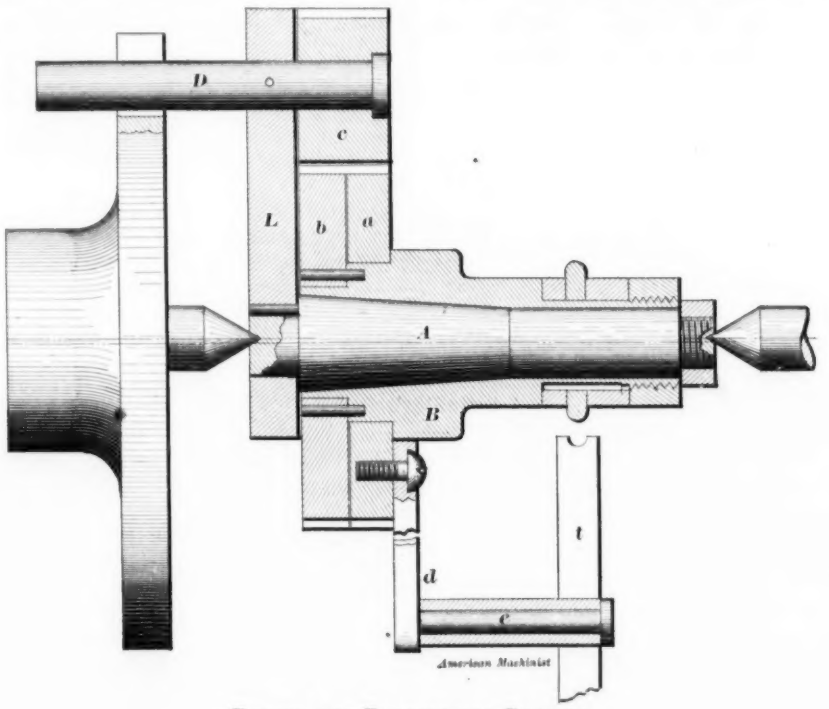
are so arranged as to be capable of easy adjustment while in the flue, which feature admits a close gauging for securing the best results.

The knives are so placed as to be self-sharpening, and it is claimed that they will continue in serviceable condition until completely worn down.

These scrapers are regularly made in sizes suited to from 2-inch to 4-inch tubes by Essex Bros. Manufacturing Company, Lorain, Ohio.

A New Device for Backing-off Milling Cutters.

We present herewith a longitudinal section of a device for backing off milling cutters by a tool held in the tool post of a lathe in the ordinary manner, the backing off being such that the cutter can be ground without alteration of shape, and the device so constructed that all that is necessary is to place the cutter upon an arbor in the ordinary way, place the arbor upon the lathe centers (of any lathe), start the lathe, and feed the tool in by the cross-feed screw to take the desired cut the same as though a plain ordinary job of turning were being done.



Device for Backing-off Cutters.

It will be concluded, no doubt, that a device which does this must be somewhat remarkable, and such is really the fact, as we shall show. Referring to the engraving, *t* is the cutting-off tool supposed to be held in the tool post, *A* is an arbor which has centers slightly eccentric, *i. e.*, as the arbor turns in the lathe upon the centers it has an eccentric motion of the required amount necessary to give the cutter a motion to and from the tool by which it is backed off. This arbor *A* turns freely within the sleeve *B*, upon which the cutter is placed, and while the arbor *A* turns with the lathe, being driven direct by the lever *L* and driver *D*, the sleeve *B* is driven much more slowly and intermittently by means of what we believe is an entirely new arrangement of gearing, which we shall now describe.

The gear wheel *a* is a running fit on the sleeve *B*, so that the sleeve can rotate freely within it. To this gear *a* is attached the arm *d* carrying the pin *e*, which rests upon the tool, and thus prevents the gear *a* from turning. The gear wheel *b* is keyed or pinned to the sleeve *B*, and the pinion *c* engages with both these gears, while it is free to revolve upon the driver pin *D*. If gear wheels *a* and *b* had the same number of teeth, the pinion *c* would simply revolve about them, and neither *a* nor *b* would have any rotary motion, though, for the reason previously stated, the arbor *A* would revolve with the lathe, and the whole device would have a small eccentric motion. On the other hand, if wheel *b* had a few teeth less than *a*, but evenly spaced, it would have a slow but continuous motion forward. In reality, it is indexed for the same number of teeth for half its circumference, and while the pinion *c* is going about this semi-circumference *b* has no motion, but the other half of the circumference of *b* is indexed for a few less teeth, and when the pinion *c* is passing around this semi-circumference wheel *b*, and, consequently, sleeve *B* and the cutter have a forward motion, and this forward motion is timed, by construction, to take place when the eccentric motion of the arbor *A* is towards the cutting tool.

Thus the device when in the lathe behaves in a manner well calculated to give a machinist who sees it for the first time a new sensation, its cycle of operations being as follows: Supposing the tool to be just starting at what is to be the cutting edge of a tooth in the cutter, the latter is slowly rotated, and at the same time moved toward the tool to give the required clearance. When the next gap in the cutter is reached, the cutter stops rotating, and at the same time commences to recede from the tool until time for the cut to begin on the next tooth, and all the while the lathe is running steadily, making as many revolutions as there are teeth in the cutter while the cutter revolves once.

As the arbor *A* is continuous from end to end of the device, the cutter is held quite rigidly, and as this arbor is in precisely the same position upon the centers during the cut upon each tooth, the teeth must be alike.

In the tool seen at work by the writer in the shop where it originated, the pin *e* was driven into a stock which was held in the tool post, and the arm *d* rested upon this pin, the actual cutting tool being, in that case, a thin plate of the proper form fastened to the stock *t*.

It is obvious that if a long cutter were to be backed off, any suitable cutting tool could be used, and the carriage feed thrown in. In this case the tool would simply move along under the pin *e*—a movement which would be greatly facilitated by the slight other motion of *e* upon *t* caused by the eccentric. Then if the teeth in this long cutter should be spiral, or, more properly speaking, helical, a guide of corresponding form could be substituted for the straight pin *e*.

Upon this device, Mr. S. M. Balzer, 39–41 Cortlandt street, New York, has been recently granted letters patent.

It is announced that the State Department is preparing an "International Catalog of Exports and Imports." This is designed to aid commerce between the United States and the "Latin-American" countries, and will be a uniform system of nomenclature of articles of merchandise. The terms will be published in English, Spanish and Portuguese.

Trolley Ears, Line Hangers and Pull-offs.

The accompanying cuts illustrate some of the details for trolley lines that are being introduced by Messrs. Butterworth & Lowe, of Grand Rapids, Mich.

It is claimed that these devices while costing the least to fit up and apply, are capable of withstanding the roughest usage—that where it becomes necessary to replace by reason of damage the construction is such as necessitates the shortest possible delay.

The trolley ear is tightened upon the wire by a single screw, which is amply strong to prevent any slipping from a chance blow of the trolley wheel.

The tightening screw being made of Tobin bronze, does away with the annoyance and delay experienced from the corrosion of other metals exposed to weather and electric currents, when renewals have to be made under running conditions. Malleable iron yokes can be had for use with the hanger, where the latter is not to be "wired" to the supports.

The above-named company does not propose to manufacture these devices, but to furnish patterns and license trolley companies to make them in their own repair shops—the manufacture being a very simple operation.

TROLLEY EARS, LINE HANGERS AND PULL-OFFS.

LETTERS FROM PRACTICAL MEN.

Modern Versus Ancient Lathes.

Editor American Machinist:

It is usually conceded that the requirements of modern shop practice are much more severe than formerly, and that the conditions for which machine tools are designed and built to-day are different from what they were, say, ten years ago.

Builders of all classes of machinery are governed by a desire to produce something which will meet the approval of users, and consequently find a market for their output. Due to this *common weakness* it naturally remains for someone, who either has passed the useful period of his career, or another who sees merit in foreign productions only, to criticise that which is in a commercial form.

From the description of the process quoted by "Old Timer," in your issue of February 28, 1895, necessary to make the changes required for right and left-hand screw cutting, it is very evident that the machine in question is anything else but a fair example of a modern engine lathe, such as are placed on the market by our prominent tool builders.

Would it not be advisable before taking such an aggressive stand, if anxious to be just, to select that which is in accordance with the march of progress, rather than some inferior production?

The American tool builder has designed and constructed his machinery to meet a certain demand, *i. e.*, he has catered to the wishes of the majority of his customers. When a new design is brought out, he is usually governed simply by a consensus of opinions of the users of his tools, and by the suggestions of his daily experience. Therefore, the individual who is entitled to the sobriquet "Old Timer" or "Old Fogy," as the case may be, will always have the opportunity to find fault with the machine of the period, because it does not revive the memories of his bygone days.

Despite the fact that the lead screw of an engine lathe is rarely used 10 per cent. of the time during which the machine is in operation, somebody is continually calling attention to the fact that it should not be placed on the outside of the lathe bed, which, with few exceptions, is the general practice.

Reference to the position of rack and rack pinion is seldom made, even though the resistance of heavy roughing cuts is, against them, much greater than that on the screw and nut occasioned by screw cutting.

Very few ancient lathes need be examined in order to find one with the lead screw placed in or near the center of the bed. Now why was this practice discarded?

Simply because in daily use the screw in its exposed position formed a convenient lodging place for chips, dust, etc., and never was in condition for use without first being thoroughly cleaned, which was no simple task, being difficult to get at.

Gigantic intellect is not required to realize that it would be desirable to place lead screw and feed rack as near the point of resistance as possible. It is preferable, however, to counteract the unequal wearing tendencies caused by their present location by increased sliding surfaces, than to complicate the lathe to the extent necessary to place them near their theoretically correct position.

Before closing my remarks on the subject of lathes, let me add that while rigidity and power necessary for removing stock are essential in a high degree, does their importance, let me ask, outweigh the value of convenience, ease of manipulation, and general adaptability to finishing work a step beyond the roughing process?

From the writer's observation, it is apparent that most users of ironworking machinery are careful not to waste a large amount of material simply to test the capacity of their equipment, but design their product with reference to economy even in this respect. Hence we have the "American engine lathe." ED. A. MULLER.

Weight and Mass.

Editor American Machinist:

I have been considerably interested in this subject which has been more or less discussed in the columns of your paper lately, and must confess to having learned some things which, though simple, and, perhaps, very well known by most people, were nevertheless new to me, and have further created a desire on my part to know more upon the subject. For instance, in Professor Wood's article in the issue of January 24th, I learned for the first time that bodies of matter attract each other only when without each other's circumferential surface, and that inside of a hollow sphere there is no such thing as weight. I had always supposed that since the lines of force of gravitation were toward the center of a body of matter, another and smaller body if let free (at a distance not too great from the surface of the first) would tend towards the center of the first, and keep on going until it got there, too, provided the substance of which the first was composed would admit of it. In other words, I had always imagined the force of gravitation as emanating directly from the center of the earth (taking it as an example), and had always thought that could there be a shaft or hole made from the surface to the center of the earth and a cannon ball dropped into it that the latter would get there at no snail's pace, and would keep on going till it reached the center, and further, too, on account of its momentum, going back and forth past the center till like the pendulum of a run-down clock it would at last come to rest exactly in the center. But in the light of what I have learned about the hollow sphere, I don't see how this could be possible. If the fundamental principles of the law of gravitation are the same with all bodies, and if after you get inside a hollow sphere there is no gravitation, it seems to me that the same rule ought to apply to the earth, and that, therefore, a cannon ball dropped in a hole, as I have said, ought by rights to hang suspended in space after it had gone a distance equal to the thickness of the supposed shell of the hollow sphere, which, indeed, it might do, though I think I would rather have the cannon ball do it than to try it myself. We can, of course, suppose this shaft not to contain any air, in which case I should hate still more to jump into it. To be sure, if a cubic foot of iron was let fall from a balloon one mile above the surface of the earth it would stop after penetrating the substance of the earth a certain distance and be at rest, and, perhaps, this could be taken as an instance of one body having no attraction for another when the latter is within its circumference. And yet I cannot see what would hinder the cubic foot of iron from weighing about as much as it ever did, or why the force of gravitation is not there the same as on the surface, but kept from manifesting its power by the intervening substance of the earth.

Professor Wood supposes the inside of the hollow sphere to be composed of a "homogeneous substance," and gives an illustration of a weight (or what would be a weight outside of the sphere) attached to a cord and *put in motion* in this homogeneous substance, which shows that this substance cannot be solid matter as we understand it, and if it is not solid matter it seems to me we might easily suppose it to be the same kind of substance of which the hole to the center of the earth might be composed, viz., air, and that the conditions would be similar in both cases. Though, of course, we could *suppose* this homogeneous substance to be solid matter, and *suppose* another piece of matter capable of being set in motion by the slightest force within it, and probably that is what we are to do in this case. And while we are in the supposing business, suppose a hole to be made through the shell of this sphere and a weight or body happening to be in line with this hole attracted by gravitation, would the weight stop after passing the shell, or would it go on toward the center? If there is no force of gravitation in the sphere when the shell is whole or solid, there cannot certainly be any in it when there is a hole cut through it, otherwise it would be the hole and not gravitation that forced the weight toward the center.

But all this argumentation on my part only goes to show how ignorant I have been and still am on this subject; and it also shows, at least to me, that I have a real desire to know more about it. I do not want to be understood as trying to contradict Professor Wood or anybody else; his theory is the same as that given in cyclopedias and other works, I find, and is without doubt entirely correct. I am merely, for my own satisfaction as much as anything else, trying to tell what there is about the subject that puzzles me.

And in Mr. Chas. T. Porter's article of February 28th, on "Weight and Mass," there is another thing that puzzles me. He says there, "We shall see that weight is not a quality of matter, that it is only the attraction of the earth." Now, if this be true why is it that the earth has a greater attraction for a cubic foot of iron than it has for a cubic foot of wood? One displaces as much air as the other and has as great a mass, and as we are taught that the weight of a body is in direct proportion to its mass, and if, as Mr. Porter says, the substance of a body has nothing to do with its weight, I cannot see why the earth should not have the same attraction for one of these substances as the other, or, in other words, why wood should not be just as heavy as iron.

Another thing which nobody seems to take any notice of, but which troubles me some, is the pressure of the air. It is said that a feather and a bullet fall with the same velocity in a vacuum. In view of this fact, it would seem to me that the air cut quite a figure in the manifestation of gravity, or the force of gravity, yet I suppose I must be mistaken as nobody seems to take it into account when treating on the subject.

Altogether the subject is something of a puzzler to me. It may be only my natural thick-headedness, but it does seem to me that there is in it an uncommonly large number of stone walls for a fellow to butt his head against. ANTI-KNOW-ALL.

Editor American Machinist:

Your contributors, Mr. Wood, Mr. Freeland, and Mr. Porter, have each made a praiseworthy effort to present the distinction between weight and mass in such a manner that the practical man unused to dealing with such problems could understand it, yet they each seem to think that it is a problem easily comprehended if it is only explained in the best way. The fact is that it is not easily comprehended or there would not be so many mechanics ignorant of it. The difficulty is that there are few who understand the matter, who can at the same time fully realize the mental attitude or condition of the man who finds it difficult to master the problem.

Being one of the latter sort of men I will try to tangle up the matter a little, with the hope that somebody can give us other illustrations to make the matter as clear as possible. g = gravity = 32.166. Mass $\propto$ weight $\div$ 32.166. Why is it necessary to perform this operation to find the mass? Suppose we had a weight of 32.166 pounds, then the mass would be 1. Suppose also that our unit of length instead of being one foot were made 32.166 times longer than it is. Call this new unit a perch, and then a falling weight impelled by gravity will at the end of one second have a velocity of 1 perch; then gravity would = 1. Now take the same weight as in the first example, 32.166 pounds $\div$ 1 = 32.166. Here we have a mass 32.166 times as large, yet the weight is the same, and nothing has been done but alter the unit of measure, for the actual velocity due to force of gravity is the same in both examples. Or, suppose that instead of taking gravity at 32.166 feet, we reduce it to inches which will be 386 inches (nearly). Then 32.166 $\div$ 386 = .083 = mass. Here we have mass again for the same weight, but it is $\frac{1}{386}$ times that found in the second example.

By a little simple juggling with figures we find mass increased or decreased enormously, and it is no wonder the practical man finds it somewhat difficult to comprehend.

When it is desired to find the mass of a body at the center of the earth where the force of gravity is neutral, and therefore the body cannot be weighed, the formula given is force $\div$ velocity = mass. For example, we will say a force of 60 pounds produces a velocity of 5 feet per second, then mass = 60 $\div$ 5 = 12.

Suppose the feet were reduced to inches,

then force 60 pounds ÷ 60 inches = mass = 1. Here is mass again only $\frac{1}{32}$ as large as at first, but the same force has moved it the same distance. Mass seems to be a very elusive thing, for $\frac{1}{32}$ of one has got away, and the practical man does not know where it has gone to.

What is mass? Webster's dictionary says: "The quantity of matter which a body contains, irrespective of its bulk or volume. It is proportional to the body's weight, though the two terms are not identical." Webster was accounted a well-educated man, but he evidently inspected mass lightly at arm's length, and the practical man gets no comfort there.

If the practical man could only have a scale which he could use to determine the mass of a body as readily as he measures its dimensions, the problem would not appear so difficult.

To put the question in a practical way I will ask a problem. If a sled of one pound weight were placed on ice and assumed to move without friction, how much force in pounds will it require to move the sled one foot in one second? How much force will be required to move it two feet in one second?

The person answering this should give the complete process of solving the problems, and give the reason for each operation in as plain and simple language as possible.

It would also be equally interesting to have the relation between weight, mass and centrifugal force explained in like manner, so I will suggest a problem. How much centrifugal force will one pound exert at a radius of one foot moving at a velocity of one foot per second? How much at a velocity of two feet per second?

Bell Crank.

The Proposed New Standard Screw Thread—Skill Required in Machine Shops.

Editor American Machinist:

Since the appearance of articles in your paper, January 3 and 24, 1895, on the proposed new standard thread (or, as it will be probably called, the "*acme standard*," perhaps it would be well to call it that now), I have tried to give the matter some thought, and as a mechanic I am strongly in favor of adopting a "standard angle thread," the angle of which will be 29 degrees, and the *working depth* will be one-half the pitch. I would recommend that as fast as we can change from the square thread (for general work) to the above angle thread, to do so, and I am convinced that we will find it an improvement, and also that an economy will be effected. In your issue of May 3, 1893, I referred to this matter.

When apprentice boy in 1872 to 1876 with the Brown & Sharpe Mfg. Co., I cut lead screws the angle of which was 14½ degrees, or the included angle 29 degrees. In 1888 and 1889, in one of the departments I had charge of (for the above company) we cut large numbers of square thread lead screws, and at that time I first started out to try and change from the square thread to the angle thread, and at that time could find no practical reason for not doing so. I talked to about every intelligent mechanic I met for months, and among them one of the leading manufacturers of taps and dies, who I found was strongly in favor of the change. In later years Mr. A. W. Handy called at the works introducing "*acme bolt-threading machines*," and I soon found that he was working up the angle thread. I want to say here that it is a good proof that a change is in order when we find the manufacturers of bolt and screw machinery recommending changing from the square thread to the angle.

In reading over Mr. Powell's article, January 24th, it occurred to me that it would be interesting to your readers to know something in detail of his *experiments*, as he says in his article, "I have experimented with the 29-degree threads." It seems to me that there would not be any noticeable difference if the angle was 28 degrees or even 30 degrees. The angle of the standard rack as well as worm is 29 degrees, and this, to my mind, is one of the strongest reasons for adopting the same angle for screw threads.

As to the credit and glory of originating this thread, I hope the time is past among mechanics when we look for glory; it does not help our bank account, or any other account. One of our poets says: "Glory is like a circle in the water, which never ceaseth to enlarge itself, till by broad spreading it disappears to naught." Mr. Powell

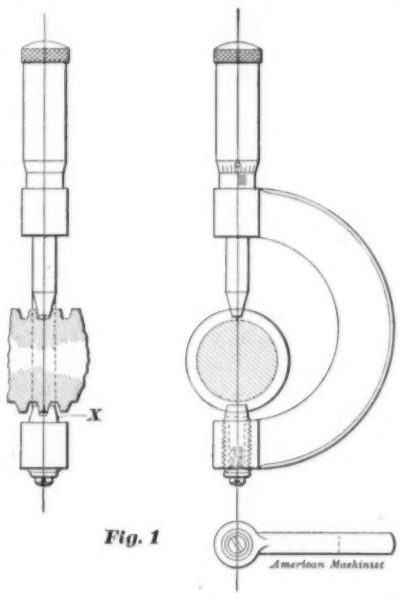


Fig. 1

refers to the advantage of his system by saying, "In dimensions found on the workman's scale, and which he can measure without the use of micrometer calipers, as are necessary in the so-called 'acme standard.'" Now the only thing I can understand that one can use the scale for is to measure the pitch or number of threads to the inch, and this operation would not be called for, except when we first commence to cut and to prove that our end gears are correct.

The micrometer caliper is fast coming into daily use; for years it was generally thought that this caliper was designed for the tool maker only. My experience has led me to believe that the tool maker uses this caliper a great deal oftener than his work calls for, and that the machinist (as we call him) does not use it half as much as his work calls for. In fact, I do not know how to cut an angle thread to its proper diameter so well as by using the micrometer caliper (see Fig. 1), which shows two views of this micrometer caliper. I have used it for measuring worms, and found it to be very satisfactory. The caliper shown will measure from 1 inch to 2 inches. The anvil *X* when found not to be the proper size, can easily be changed. I would, however, recommend having about three calipers, with different sizes of anvils, which, I think, would be all that is wanted for the different screws that will be cut in the average shop.

In your article, January 3, 1895, where you refer to gauges for the angle thread, I think gauge, Fig. 4, is the only one I would recommend using. The following will show what I would recommend in place of the other gauges: Figs. 2 and 3, gauges for grinding tools; gauge, Fig. 3, it will be noticed has an adjustment, and can be set to read in thousandths of an inch, and, of course, is intended for measuring the width of point of tool.

In our days, mostly every shop that is doing work to the best advantage has a surface grinding machine, or its equivalent. A fixture should be designed to go on this machine that will allow the operator to grind the thread tools first on bottom, second the angles, and last grind the point to the desired width. This fixture should only be designed for 29 degrees, and when completed and it is found that a tool ground by it fits gauge, Fig. 2, then your troubles will be over so far as always getting the correct angle.

Fig. 4 shows a thread tool suitable for cutting 4 pitch, when dull should be ground on top (not on end or sides).

I recommend that the outside diameter of the screw be turned or ground standard or under, say, .0015 inch, and that the outside diameter of tap be turned .0185 inch to .020

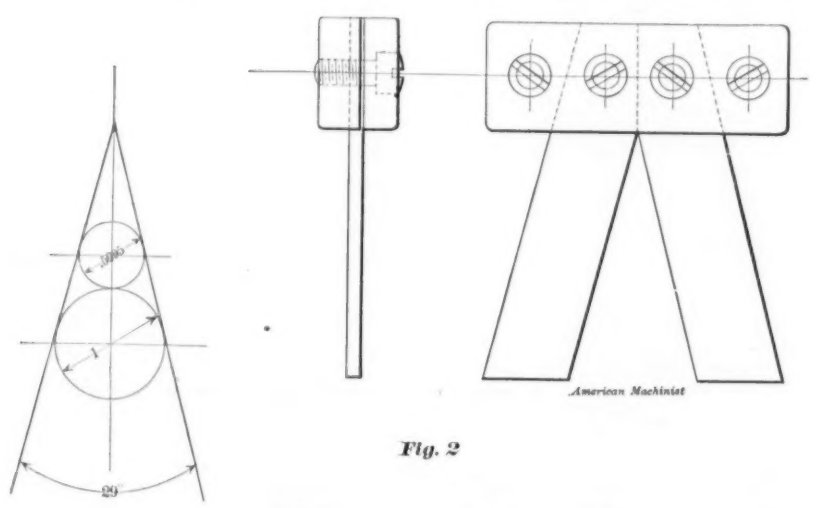


Fig. 2

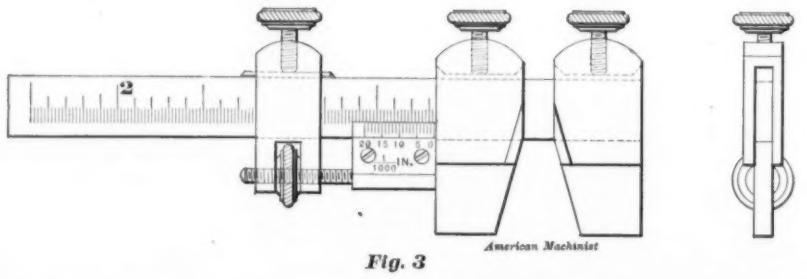


Fig. 3

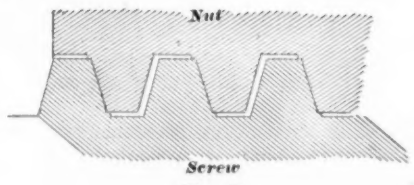


Fig. 5

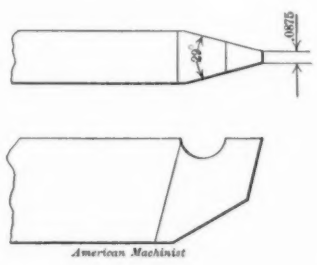


Fig. 4

The New Screw Thread.

inch over standard, the diameter of bottom of thread of screw .0215 to .020 inch under standard, the diameter of bottom of thread of tap standard, or in other words, the same size as tap drill. For illustration, a nut 1¼ inches diameter, 4 pitch, diameter of tap drill one inch. My reason for recommending making the diameter of bottom of thread of tap the same as tap drill is that should the workman fail to use a drill or bore the hole to the correct standard, the tap would either fail to do its work or perhaps cut the hole to proper size. A very good plan used by some of the tap manufacturers is to make a tit or guide on the end of the first tap, with diameter the same as tap drill; this tit acts as a guide to keep the tap straight, and always calls for a hole that is standard or over.

My reason for recommending clearance top and bottom of threads is not to allow for "take-up," but simply to make a working clearance and provide against any bearing or fit outside of the sides of thread.

In Mr. Powell's paper he refers to the square thread, and says: "The fact that there is great difficulty in making proper fits, and the entire lack of provision for 'take-up' in case of wear should cause it to be cast aside by practical men."

Now, I doubt very much if there is any advantage in the angle thread over the square so far as its ability goes to "take up."

Fig. 5 will show a part section of a screw and nut which is worn, and by referring to this you will at once see that this nut cannot be very well "*taken up*."

At some near date, Mr. Editor, I will send you a memorandum of my experience with the micrometer caliper in making limit gauges for United States standard screws, and the results obtained. Gauges made in the State of Pennsylvania, screw in Connecticut, taps in Rhode Island, and it was surprising to find that all three were the proper size to allow of screws following tapped holes just right; and I am sure if the micrometer caliper is adopted, as shown in Fig. 1, that the same results can be obtained in the "*new screw thread*," angle 29 degrees.

Now, in closing this rambling article, I wish to refer to the closing remarks of Mr. Powell's letter, where he says:

"Don't make the mistake of trying to force a new thing on the public if it requires any more skill to make than the old, and especially in case of this so-called 'acme screw,' which necessitates considerable mathematics to understand."

Just here is where I beg to widely differ with Mr. Powell. We want more mathematics in our shops. Many a job is done to a great disadvantage in our shop because mathematics is not used.

We are introducing every year work and methods that require more skill than the old, but I also wish to say that many of our old and expensive methods are done away with. I can remember when a piece of work came from the planing machine, it was supposed generally that it was as true as could be made. Later, we commenced to scrape, make surface plates, straight-edges, etc., to get better work. It requires more skill to run a street car by electric power than by mule power.

In looking back about 23 years, and thinking how we used to do things in the machine shop, I am not so sure but to-day we require more skill to do our present work than we did then.

Gauges, Figs. 1 and 2, were designed and first made at the Brown & Sharpe Mfg. Co. by some of their engineers.

Gauge, Fig. 3, was designed by Mr. D. D. Donavan, in charge of shop tools at the Brown & Sharpe Mfg. Co.; a similar gauge is shown in the Pratt & Whitney Co., Book "Standards of Length," pages 146 to 164; this gauge was also designed and made at the Pratt & Whitney works.

I am not in possession of the date of either of the designs of caliper as shown in Fig. 3, or I would gladly give them. Either of these are first-class, and will do the work for which they are designed.

Philadelphia. John A. McGregor.

The Factor of Stiffness in Engine Design.

Editor American Machinist:

Mr. Halsey's remarks on "Rules for Engine Proportions," in the February 14th issue of the American Machinist, are to the point. The design of high-speed engines, with the exacting demands made upon them, could be improved to the profit of many builders if they would investigate

the "factor of stiffness," and change their designs to comply with it.

Many builders have two or three points, and often good ones, which they especially dote upon and commend, while other features of equal importance are seemingly totally neglected in the design. I have in mind a certain make of center crank type, three sizes of which I have observed in operation. The tendency in all was to run hot in the main bearings and crank. The diameter of the shaft is less than 40 per cent. of the cylinder diameter, speed about 300.

On one size it was found by disconnecting the valve and moving it by hand, that the shaft would be sprung by 60 pounds steam pressure enough to vary the distance between the disks more than $\frac{1}{32}$ of an inch.

A certain other engine, although having its weak points, is of good general proportions and has won an enviable reputation for coolness of running.

The crank shaft and pin should have a diameter of nearly or quite one-half that of the cylinder. The slide area of the cross-head is sometimes too small, as is also the cross-section of the piston rod.

The frame in many cases is so light that it will warp under the normal load of the engine, to say nothing of what it will do under an overload, such as high-speed engines are often called on to carry. In many cases a wrong distribution of metal has as much to do with this as the lack of weight.

Carbondale, Ill. FRED. W. RICHART.

Coiling Device—Turning Shafting—A Handy Key Seater.

Editor American Machinist:

For a certain hurried job it was necessary to have some coils of German silver wire, No. 19 Brown & Sharpe gauge, which were to be 20 feet long, $\frac{3}{16}$ inch outside diameter and six turns per inch. The usual method adopted in that shop for coiling open springs was to wind the wire over a revolving mandrel, holding a bent hook as a spacer between the last coil and the wire as it went on to the mandrel. Of course, with such a long coil this was out of the question, but it was an easy matter to reverse the process and revolve the reel of wire and the spacer. The mandrel was held stationary.

A small speed lathe was fitted with the hollow center *B* shown in the accompanying sketch, Fig. 1. This was drilled to the outer diameter of the coil ($\frac{3}{16}$ inch) for part of the way and larger at the back. A piece of brass (*A*) was fitted into this center and drilled to allow the wire to enter at a tangent to the coil. By filing it at the angle shown, *A* acted as the spacer. The mandrel, a piece of wire five feet long, was drilled to hold the wire at the beginning, and after it was wound for its entire length the mandrel was slid back and it and the coil held from turning by a wooden clamp. The reel of wire was mounted on the face plate and revolved with the spindle, as well as on its own axis. Practically, the spring was about 250 feet long, though it was cut into 20-foot lengths. The rig was cheap, simple to make and effective.

I saw a shafting lathe the other day which was turning $1\frac{11}{16}$ inches soft Bessemer steel shafts at the rate of five feet per minute and doing good work. Is there much better time made on this class of work, and what material makes a good bushing for the back rest, one that won't rough up or cut from heavy duty?

Instead of the slow process of cutting keyways in pulleys, gears, etc., on the planer, shops who cannot afford a keyseating machine may easily rig up their drill presses so they could do the work in about half the time. Build up a wooden pulley (say for 2 inches or $2\frac{1}{2}$ inches belt) around the hand wheel, and belt to it from a separate countershaft. Place a bushing in the table and use a keyseating bar similar to a boring bar. The cutters may be pivoted as shown in sketch, Fig. 2, and fed into the work by loosening the set screw. On a drill press having a power feed, the operation at the end of a cut would be to throw out the feed, run back the spindle, adjust the screw for the next cut and throw in the feed. This is done in much quicker time than a planer could do the work, as the bar is supported at both ends instead of one as in the latter, and allows a much heavier cut to be taken. The belt speed in cutting keyways is quite high, and the belt will carry a heavy cut. The work is no more severe than heavy

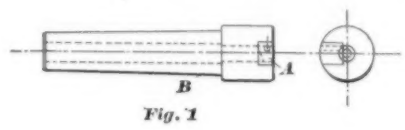


Fig. 1

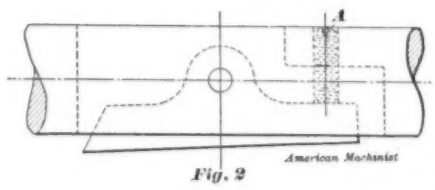


Fig. 2

drilling, and the writer has known of a drill press which for years has done good work in boring and keyseating large spiders. For tapered keyways a beveled plate could be bolted to the table.

This idea of supporting both ends of the bar is used in one at least of the modern keyseaters and possibly in others.

Jamaica Plain, Mass. WM. SANGSTER.

The Proposed New Screw Thread.

Editor American Machinist:

I was greatly interested in "A Proposed New Standard Screw Thread," as described in your issue of January 3d, and I have worked out the accompanying table, which presents the data relating to the new thread more completely than was there stated, for my own use. Believing a considerable number of your readers will be glad to have the information put in this shape, I send it to you for publication. In the article referred to there was no relation between the number of threads per inch, and the outside diameter of screw proposed. Different designers use different ratios of pitch to diameter, but I think it will be conceded that the proportion of half the number of threads, or twice the pitch of the U. S. standard screw thread is a good one, and answers in a majority of cases, and this proportion I have adopted in the table. The equations for finding the screw elements are also given, so that one may easily interpolate any size desired for any pitch or any diameter. WALTER S. DIX.

Meeting of the Executive Committee of the Manufacturers' Association—Vice-presidents.

The executive committee of the National Manufacturers' Association held a meeting in Philadelphia on the 13th, at which President Dolan presided. Additional vice-presidents were selected, and the complete list of these now stands as follows:

Hon. Warner Miller, Herkimer, N. Y.
Wm. S. Shallenberger, Pittsburgh, Pa.
John B. Kirk, Chicago, Ill.
Thos. P. Egan, Cincinnati, O.
L. D. Kingsland, St. Louis, Mo.
Frederick W. Sivyer, Milwaukee, Wis.
P. E. Studebaker, South Bend, Ind.
Arnold B. Sanford, Fall River, Mass.
R. G. Salomon, New Jersey.
John B. Howarth, Detroit, Mich.
Pliney Jewell, Hartford, Conn.
M. R. Vanderkloot, Coronado, Cal.
C. A. Pillsbury, Minneapolis, Minn.
Thos. Deford, Baltimore, Md.
Chas. Fletcher, Providence, R. I.
Theo. Ahrens, Louisville, Ky.
Chas. W. Armour, Kansas City, Kan.
J. A. MacMullen, Biddeford, Me.
Levi C. Barton, Omaha, Neb.
Dabney Crenshaw, Richmond, Va.
C. D. Mitchell, Chattanooga, Tenn.
H. C. Tossey, Sherman, Tex.
J. F. Hanson, Macon, Ga.
Ex-Gov. H. C. Warmouth, New Orleans, La.
H. F. DeBardelaben, Birmingham, Ala.
W. Robertson, Denver, Col.
W. H. H. Green, Seattle, Wash.
John Wilkes, Charlotte, N. C.
Thos. Somerville, Washington, D. C.
Col. Franklin Fairbanks, St. Johnsbury, Vt.
John R. London, Rock Hill, S. C.
John A. Lewis, Meridian, Miss.
W. B. Scott, Wheeling, W. Va.
Geo. H. Sellers, Wilmington, Del.
Fred'k Lewis, Bartow, Fla.
Hon. J. L. Foote, St. Paul.
J. L. Abernathy, Leavenworth.
Ex-Mayor Shakespeare, New Orleans.
Thomas F. Evanson, Seattle.
John T. Campbell, Washington, D. C.
H. G. More, Edgemore, Del.
Elwyn W. Lovejoy, Lowell, Mass.

The next meeting will be held in Chicago, October 15th.

Feed-Water Heater Ratings.

The Association of Feed-Water Heater Manufacturers has decided that hereafter all heaters made by members are to be rated by the amount of surface, buyers being given the correct area of coils, etc., for guidance in selection.

This will be a great advance over the heretofore prevailing habit of rating by a so-called horse-power unit, which has no definite meaning as regards the work required of the feed heater.

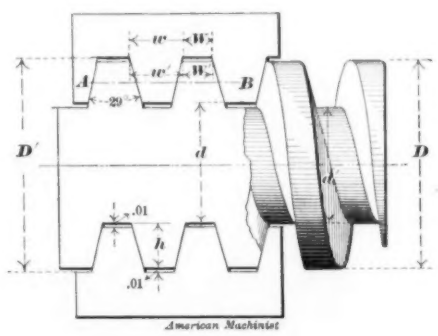
Prospective buyers will hereafter have a basis on which to make an intelligent choice.

The loss of Nikola Tesla's electrical laboratory and work shops by fire is much more than a mere personal loss to him and his workmen, for it must be regarded as a positive impediment to scientific advance; at least for a time. Tesla's work is, perhaps, the most important that is now being done in electricity. He is undoubtedly a very remarkable genius, whose whole soul is wrapped up in his profession. It is a matter for sincere regret that this work should be interrupted even temporarily by this unfortunate fire, and it is to be hoped that he will speedily recover the lost ground and be even better equipped for pursuing his researches into fields of science where others find it difficult even to follow him.

"ACME STANDARD" SCREW THREAD.

PROPOSED BY A. W. HANDY.—AMERICAN MACHINIST, January 3, 1895.

CALCULATED AND ARRANGED BY W. S. DIX.



The pitch assumed for a given diameter is the one commonly used, viz., twice that for U. S. Standard Screw Threads. The thread is symmetrical about the axis *A B*.

The dimensions are given by the following formulæ:

(1) $h = \frac{1}{2n} + .01$. (2) $W' = \frac{1}{2n}(1 - \tan. 14\frac{1}{2}°)$. (3) $W = W' - .02 \tan. 14\frac{1}{2}°$. (4) $w' = \frac{1}{2n}(1 + \tan. 14\frac{1}{2}°)$. (5) $w = w' + .02 \tan. 14\frac{1}{2}°$. (6) $p = \frac{1}{n}$. (7) $D' = D + .02$. (8) $d = D' - \frac{1}{n}$. (9) $d' = d - .02$. (10) $S = \frac{\pi}{4} d'^2$.

Only the shape of thread is due to Mr. Handy, not relation of diam. to thread.

Threads per Inch.	Depth of Thread.	Width at Bottom of Thread.	Width at Top of Thread.	Thickness at Root of Thread.	Space at Top of Thread.	Pitch.	Diam. of Screw.	Diam. of Tap.	Diam. to Bore Nut.	Diam. at Root of Screw.	Area at Root of Screw.
n	*h*	*W*	*W'*	*w*	*w'*	*p*	*D*	*D'*	*d*	*d'*	*S*
10	.0600	.0319	.0371	.0681	.0629	.1000	¼	.2700	.1500	.1300	.0133
9	.0655	.0360	.0412	.0740	.0688	.1111	5/16	.3325	.2014	.1814	.0258
8	.0725	.0412	.0463	.0838	.0787	.1250	⅜	.3950	.2500	.2300	.0415
7	.0814	.0478	.0529	.0951	.0899	.1428	7/16	.4575	.2947	.2747	.0593
6½	.0869	.0519	.0570	.1020	.0968	.1538	½	.5200	.3462	.3262	.0836
6	.0933	.0566	.0618	.1100	.1049	.1667	9/16	.5825	.3958	.3758	.1109
5½	.1009	.0622	.0674	.1196	.1144	.1818	⅝	.6450	.4432	.4232	.1407
5	.1100	.0690	.0741	.1310	.1259	.2000	¾	.7700	.5500	.5300	.2206
4½	.1211	.0772	.0824	.1450	.1398	.2222	⅞	.8950	.6528	.6328	.3143
4	.1350	.0875	.0927	.1625	.1573	.2500	1	1.0200	.7500	.7300	.4185
3½	.1528	.1007	.1059	.1850	.1798	.2857	1⅛	1.1450	.8493	.8293	.5402
3½	.1528	.1007	.1059	.1850	.1798	.2857	1¼	1.2700	.9643	.9443	7003
3	.1767	.1184	.1236	.2149	.2098	.3333	1⅜	1.3950	1.0417	1 0217	.8038
3	.1767	.1184	.1236	.2149	.2098	.3333	1½	1 5200	1.1667	1.1467	1.0327
2¾	.1918	.1296	.1348	.2340	.2288	.3636	1⅝	1.6450	1.2614	1 2414	1 2103
2½	.2100	.1431	.1483	.2569	.2517	.4000	1¾	1.7700	1.3500	1.3300	1.3893
2½	.2160	.1431	.1483	.2569	.2517	.4000	1⅞	1.8950	1 4750	1.4550	1.6627
2¼	.2322	.1596	.1647	.2849	.2797	.4444	2	2.0200	1.5556	1 5356	1 8520
2¼	.2322	.1596	.1647	.2849	.2797	.4444	2¼	2.2700	1.8056	1.7856	2.5043
2	.2600	.1802	.1853	.3198	.3146	.5000	2½	2.5200	2 0000	1.9800	3.0791
2	.2600	.1802	.1853	.3198	.3146	.5000	2¾	2.7700	2 2500	2.2300	3.9057
1¾	.2957	.2066	.2118	.3648	.3596	.5714	3	3 0200	2 4286	2 4086	4 5556
1¾	.2957	.2066	.2118	.3648	.3596	.5714	3¼	3.2700	2.6786	2.6586	5.5585
1⅝	.3 77	.2229	.2281	.3924	.3873	.6154	3½	3.5200	2.8846	2.8646	6 4450
1⅝	.3177	.2229	.2281	.3924	.3873	.6154	3¾	3 7700	3.1346	3.1146	7 6187
1½	.3433	.2490	.2471	.4247	.4195	.6667	4	4.0200	3.3333	3 3133	8.6182
1½	.3578	.2527	.2578	.4429	.4378	.6956	4¼	4.2700	3.5544	3 5344	9.8110
1⅜	.3736	.2644	.2696	.4628	.4577	.7272	4½	4.5200	3.7728	3.7528	11 060
1⅜	.3909	.2753	.2824	.4842	.4790	.7619	4¾	4.7700	3.9881	3.9681	12.367
1¼	.4100	.2914	.2965	.5086	.5034	.8000	5	5.0200	4.2000	4.1800	13.723
1⅛	.4310	.3070	.3121	.5341	.5299	.8421	5½	5.5200	4.6379	4.6379	16 893
1⅛	.4544	.3243	.3295	.5646	.5594	.8888	6	6.0200	5.1112	5.0912	20.363
1	.5100	.2655	.3707	.6345	.6293	1.0000	...	.....	.....	.....	.....

January, 1895.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

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J. G. A. Meyer, } Associate Editors
Chas. M. Jones, } and Mechanical Engineers.

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

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The International News Company,
Bream's Bldg's, Chancery Lane, London, E. C., Eng., or Stefanstrasse 18, Leipzig, Germany, will receive subscriptions for the American Machinist, at 16/6 per annum, English currency, or 17 marks per annum, German currency, postpaid.
Subscriptions received in Paris, France, by E. Terquem, 31 Boulevard Hausmann, at 21 francs per annum, postpaid.

Subscriptions received in Australia by W. Williams, 17 and 21 Fink's Buildings, Melbourne.

NEW YORK, MARCH 28, 1895.

CONTENTS.

	PAGE.
The Cornell Dividing Engine. By Geo. F. Ballou	241
Doings at Backaway. By Joel Oldone	243
A New Flue Scraper	244
A New Device for Backing off Milling Cutters	244
Trolley Ears, Line Hangers and Pull offs	245
Letters from Practical Men: Modern *Versus* Ancient Lathes. By Ed. A. Mulier... Weight and Mass. By Anti-Know-All—Bell Crank... The Proposed New Standard Screw Thread—Skill Required in Machine Shops. By John A. McGregor....The Factor of Stiffness in Engine Design. By Fred. W. Richart... Coiling Device—Turning Shafting—A Handy Keyseater. By Wm. Sangster...The Proposed New Screw Thread. By Walter S. Dix....245, 246,	247
Meeting of the Executive Committee of the Manufacturers' Association—Vice-presidents.	247
Feed-water Heater Ratings	247
The State Department's Position as to Foreign Swindlers	248
Standard (6″x9″) Catalogs	248
The Story of a Fine Job	248
Southern Iron Abroad	248
Railroad Business Better	248
Death of Chas. E. Lipe	248
Literary Notes	248
Questions and Answers	249
Small Gas Engines—Firing Bituminous Coal. By W. H. Booth	249
A Handy Lathe Tool—A Good Soda Kettle—A Tool-room Combination. By James F. Hobart	250
Modern Furnace *vs.* Cupola Practice. By Thos. D. West	250
Machine Wipers of Raw Silk	251
New Catalogs	252
Manufactures	2 2
Machinists' Supplies and Iron	252

The State Department's Position as to Foreign Swindlers.

Ever since the publication in our columns of the exposure of the Amsterdam swindlers (first commenced by *Dixie*) we have been receiving letters from machinery manufacturers, asking for information as to the standing of certain firms or individuals in foreign countries.

Usually we know nothing of the firm in question, and can only ascertain by an investigation—a method which is open to our friends as well as to us, and can probably be more satisfactorily arranged for by them.

It having been suggested that the U. S. Consuls at various points in Europe might render valuable assistance in such matters, we inquired of the Department of State at Washington whether it would be proper for us to say that U. S. Consuls would, upon application, report upon the standing of firms within their districts, and have received a reply from the Chief Clerk, E. J. Renick, in which he says:

"The Department is unable to comply with your request for permission to state in your paper that American Consuls in the different European cities will, upon application, report upon the commercial standing and reliability of firms, as this is not one of the duties which could properly be imposed upon Consular officers. I would add, however, that the Department is now collecting a series of reports upon commercial agencies in various foreign countries, and these reports when published will probably furnish a guide for the collection of the kind of information you desire."

This "report upon commercial agencies" will, no doubt, be of great service when issued, as it will enable anyone who wishes to know about a foreign firm to correspond with a foreign commercial agency in that district, and obtain a report the same as can now be done in the case of American firms and our own commercial agencies.

And in the meantime we think likely that where any American manufacturing firm wishes to investigate the standing of a foreign firm, the Consul in that locality will take pleasure in forwarding the name of a reliable commercial agency from whom a report can be obtained. Possibly this would not come within the line of the duty of American Consuls, but from what we know of them, we think they would almost invariably be glad to be of assistance in this way.

Standard (6″x9″) Catalogs.

Some time ago we published in the department devoted to that purpose a notice of a new catalog, and inadvertently failed to state the fact that it was "standard size," 6″x9″. Thereupon we received a letter from the manufacturing concern that issued it, in which they very courteously thank us for our notice, but express their regret that *they* failed to state that the catalog is "standard size."

This letter is exceedingly gratifying to us, because it shows not only that this firm makes its catalog standard size, but that it is sensitive on the subject, and does not like the idea of having people imagine that it would, in this enlightened age of standards, issue a catalog other than standard size (6″x9″).

Perhaps our readers have begun to suspect that we propose to keep hammering at this standard catalog business until no machinist will dare to fly in the face of public opinion by issuing an irregular size of catalog, unless the catalog itself justifies the irregularity. In doing this we are, of course, working in the interest of everybody who has anything to do with catalogs, and it is to be remembered in this connection that most manufacturing establishments handle other's catalogs more than their own, and are, therefore, interested in two ways in having them standard, *i. e.*, as users and as manufacturers introducing their goods by means of them.

Others who do not belong to the enlightened confraternity of machinery builders can go on issuing catalogs of all sorts of irregular sizes if they choose, and there is no help for it probably, but machinery catalogs are destined to be standard (6″x9″).

The Story of a Fine Job.

Elsewhere in this issue will be found an article, by Mr. Geo. F. Ballou, that ought to be of very great interest to every mechanic who is capable of finding anything in his business to interest him—and the man who cannot do that is very unfortunate or very dull.

The article is simply a very modest and unassuming narrative, by a machinist and toolmaker, of his experience in working to produce the finest and most accurate possible mechanism without much regard to cost. Not many machinists work under such conditions. There is usually a balancing of pecuniary considerations against mechanical ones, and the highest mechanically possible degree of accuracy is not attained because it will not be paid for. But in the case of this screw there seemed to be absolutely no limit to the degree of accuracy attainable, except purely mechanical limits; and such a detailed and circumstantial narrative of how the work was done—of both the unsuccessful and the finally successful attempts, written from the standpoint of the practical mechanic, can hardly fail to be of interest and great value. The story will be completed in our next issue, or the week after, and we shall publish engravings and a description of the finally completed machine as it stands at Cornell University.

Southern Iron Abroad.

For some time past it has been apparent that the selling price of Southern pig-iron was approaching the point at which it would be possible to export and sell it in neutral markets in competition with English and Scotch irons, and it is now declared to be a matter of but a short time, and the settlement of a few details as to rates for shipment to the Southern seaboard, to enable Alabama and Tennessee iron to be sold in Mediterranean ports; and it is thought that if it can be shipped as ballast in cotton ships it can be placed in competition with English irons in their own territory. Important as this movement seems likely to be, it may have a bearing upon international commerce which will not be easily recognized, for it will be readily seen even by the English-American machinist, whom Professor Sweet told us about, that if American iron comes into general use over there, American lathes may fairly be expected to be able to turn it and bore it there, and that English machine shops that use American iron will not, therefore, be deterred from buying American lathes, even though tools placed in them may seem, when applied to English iron, to have entirely lost their power to cut.

Railroad Business Better.

The business of the railroads is being watched just now much closer than usual, because it is generally recognized that the condition of business with them is not only an indication of the condition generally, but also shows whether or not they will soon again be large buyers of supplies and rolling stock. It is therefore gratifying to know that most railroads are doing a better business now than for some time past, and that there is a decided tendency shown by the roads to increase their orders for supplies. Several large orders have been given for cars recently, and there is every indication that railroad business and railroad buying has passed its lowest ebb, and will now grow steadily better.

The New York Central Railroad is doing what more roads ought to do, *i. e.*, taking advantage of low prices to contract for rolling stock which is needed and the purchase of which can be put off but a short time in any event. If all the other roads that need equipment should follow this example, business would soon be better, but not all the roads that need new equipment are as well able to pay for it.

The letter of the Cleveland Twist Drill Co. in last week's issue refers to our articles regarding "the swindlers of Antwerp." This is a mistake which was overlooked. There are probably some swindlers in Antwerp, but we have no definite information regarding them. The swindlers about whom we did publish information were located in Amsterdam—a different city in a different country. The two cities have been frequently confounded by our friends in referring to the matter, and thus unconsciously injustice to Antwerp merchants is done.

Death of Chas. E. Lipe.

Mr. Charles E. Lipe, of Syracuse, N. Y., died at his home on the 17th inst., after a short illness; the immediate cause of his death being hemorrhage of the brain, induced, it is thought, by over work.

Mr. Lipe was well known as an inventor, mechanical engineer, and manufacturer. He had original ideas, and embodied them in many very successful machines for various purposes. He is best known to machinists perhaps through the milling machine which bears his name, and at the time of his death he was perfecting a turret head boring machine of novel construction. He also invented successful broom-making machinery, and a rice-hulling machine which has been largely introduced in the rice-growing countries. Mr. Lipe entered Cornell University when it opened, and was graduated in 1873. He had been a member of the American Society of Mechanical Engineers since 1883, and was forty-four years of age at the time of his death.

Literary Notes.

ELECTRICITY ONE HUNDRED YEARS AGO AND TO-DAY. By Edwin J. Houston, Ph. D. (Princeton.)

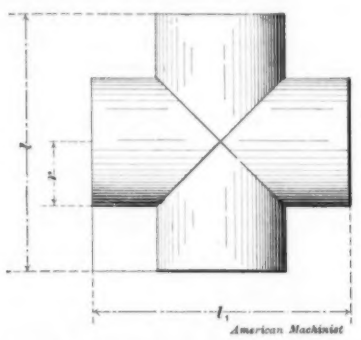
This little book is the outcome of a lecture delivered before the Electrical Section of the Brooklyn Institute. The text contains the lecture substantially as delivered, but its wide scope, which embraces the progress made by electric science practically from its birth to the present day, necessitated from the limit of time of a single lecture, a much briefer treatment of many important discussions and inventions than seemed advisable when the lecture was put in book form; and therefore many foot-notes have been added, making the treatment of the subject more complete and valuable to the student of electricity. No pretense is made of doing any more than treating, in the most general manner, some of the more interesting facts concerning those great discoveries and inventions that may fairly be considered as creating epochs in the history of electrical progress. Care has been taken to give credit where it belongs. The extracts from early writers have been made comparatively full, because of the difficulty most students experience in gaining access to the books or periodicals in which such publications first appeared. The extracts from publications concerning the more recent discoveries or inventions are less frequent, because such are either more generally known or more readily accessible. Much information as to the electrical phenomena may also be obtained from the book, as the author does not merely give the history of the discovery, but also adds a concise and clear explanation of it. The work is written in a very agreeable and interesting style, and is well worth the price to those who are interested in the progress made in electric science. It is published by the W. J. Johnston Company, Limited, 253 Broadway, New York. Price, $1.00.

We have received a copy of the second edition of "Mechanical Heating and Ventilation," by Mr. C. Huyett, heating and ventilating engineer, Monadnock Building, Chicago, Ill. In this book Mr. Huyett goes somewhat extensively into the principles underlying heating and ventilating buildings of all kinds, of which branch of engineering he has made a special study. The book is bound in flexible covers, is well illustrated, includes a number of useful tables and data, and is sold at $5.00.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(119) A. B., New York, writes: Please give me a formula for computing the volume of two cylinders of equal diameters, and intersecting each other as shown in the accompanying sketch. *A.*—Add together the lengths of the two cylinders, from this sum subtract two-thirds of the radius, and multiply the remainder by the cross-sectional area of the cylinder. Expressing this rule in symbols, we have $\pi\, r^2\, (l + l_1 - \frac{2}{3}\, r)$ = volume of both cylinders, in which r = radius of cylinders, l = total length of one cylinder, and l_1 = length of the other cylinder. If the radius is taken in inches, and the length in inches, the volume will be in cubic inches.



(120) H. M., Decatur, Ill., writes: In your issue of November 15, 1894, you have an article on "Convenient Degree Scale," by F. W. Clough. In that he speaks of a generating circle of 57.3248 inches diameter. Please explain how this degree scale can be made by the use of that circle, or in any other way. *A.*—The circumference of a circle contains its radius 6.2832 times, since there are 360 degrees in a circle, the arc of a circle whose length is equal to the radius must subtend an angle of $\frac{360}{6.2832} = 57.29$ degrees. Hence, if the radius is divided into 57.29 parts, then the arc set off on the circumference and equal to one of the parts on the radius, will subtend an angle of 1 degree. Consequently, if the diameter of the circle is 57.29 inches, the arc $\frac{1}{4}$ inch long on the circumference of this circle will subtend an angle of 1 degree. The number 57.3248 given in the article referred to is not quite correct; it is obtained by dividing 360 by 6.28, instead of 6.2832. This principle has evidently been made use of in constructing the scale.

(121) J. H. G., Greensburg, Mass., writes: Please inform me which, in your judgment, is a suitable book for learning to run a Corliss engine. *A.*—There is no choice of books treating on this subject, as there is, as far as we know, one book only published treating on this subject, and that is the "Management of the Corliss Engine," edited by E. P. Watson and published by Spon & Chamberlain, 12 Cortlandt street, New York. The best way to learn running a Corliss engine is by experience in working as assistant with an engineer who has charge of running an engine of this class. 2. Please name a book suitable for one who wishes to prepare himself for an examination for an engineer's license, and also a book treating on brass molding. *A.*—"Instructor for Procuring Stationary and Steam Engineer's License," by P. H. Zwicker, may suit you. "The Practical Brass and Iron Founders' Guide," by J. Larkin, is a good book; but you can also find much valuable information in a concise form on this subject in "The Encyclopedia of Founding," by S. Bolland. These books you can obtain from any dealer in scientific works.

(122) J. C., Jersey City, N. J., writes: On page 123 of your issue of February 14th occurs the formula $2\,\frac{\pi \sin.\,\Theta}{4 + \pi \sin.\,\Theta}\, V^2$ for the intensity of the pressure on a paddle float. Will you kindly give the authority for this formula, or the method of its derivation? I find it agrees with the values given by Trautwine only within narrow limits. *A.*—The formula is due to Lord Rayleigh, and will be found worked out in Lamb's "Treatise on the Mathematical Theory of Fluid Motion." The ordinary expression for intensity of pressure due to motion in a fluid assumes that the total volume of water passed through is set in motion as if it reached the face of the moving plane. Actually there is a certain quantity of the mass that acts upon the relatively advancing column, and forces it out of the path of direct motion, and this "spilling" effect greatly modifies the pressure. Also the ordinary formula makes no distinction between the pressure on face and loss of pressure on back of the plane, yet these forces vary independently.

(123) G. H. A., Wausau, Wis., asks: What should be the outside diameter and thickness for a ring packing for steam piston of an 8 by 10-inch engine. No means will be provided for holding the ring out against the walls of cylinder, hence the inherent elasticity will have to be depended upon. *A.*—The packing rings for the given size of piston are generally made of cast-iron, and when finished should be $\frac{1}{2}$ inch square, two rings being used for each piston. The ring is cut open in such a manner as to allow the ends to lap over each other to an extent of about $\frac{3}{4}$ inch, the lap being in a line parallel to the axis of the piston. The ring is first turned large enough in diameter to allow for the metal which must be cut out for the lap; the ring is then cut open, the ends sprung together and held in this position by a temporary pin driven through the lap; in this condition the ring is turned to fit the bore of the cylinder and finished to size, $\frac{1}{2}$ inch square; after this the pin is taken out, and the ring is then ready for placing it in the piston. Cast-iron packing rings made in this manner will fit the cylinder walls nicely all around and have sufficient inherent elasticity for a steam-tight bearing, and work very satisfactorily. Care should be taken to have a little clearance at ends of the lap to allow for expansion of the ring when steam is turned on.

(124) O. E. E., York, Neb., writes: Please give me a formula for computing the thickness of the webs of a piston for any given pressure; the construction of the piston is that of any ordinary piston with radial arms. *A.*—Multiply the diameter in inches of the piston by the square root of the effective pressure per square inch of piston, divide this product by 50 and add one to the quotient; the result will be a constant to be used in proportioning the different parts of the piston. In symbols we have:

$$\frac{D\sqrt{p}}{50} + 1 = C; \qquad (1)$$

in which D = diameter in inches of the piston, p = the absolute effective pressure in pounds per square inch of piston, and C = a constant to be used for proportioning the different parts of the piston. Now, for the thickness in inches of the arms we have $.18\,C$; total depth of piston at the center, $1.4\,C$; number of arms $= \frac{D+25}{10}$. For a piston 18 inches diameter, and with an absolute effective steam pressure of 81 pounds per square inch, we have for the constant C:

$$\frac{18\sqrt{81}}{50} + 1 = 4.24.$$

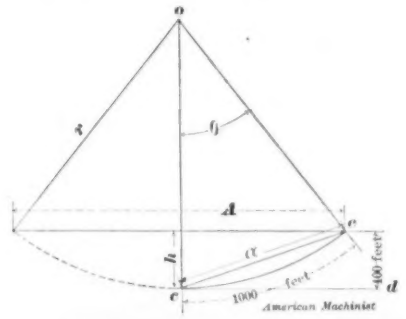
The thickness of the webs will be $.18 \times 4.24 = .76$, say $\frac{3}{4}$-inch; for the total depth of piston, $1.4 \times 4.24 = 5.93$, say 6 inches; and the number of webs will be $\frac{18+25}{10} = 4.3$, say 5.

(125) J. C. A., Chillicothe, Mo., asks: What thickness of steel should be used for fire-box patches? *A.*—We should use the same thickness of steel as is used in the fire box. 2. How much lap is allowed, and where are the center lines of holes for rivets or bolts relative to lap? *A.*—The center lines of the holes are in the center of the lap. The ordinary practical rule for determining the amount of lap is to make the distance from the center line of rivets to the edge of plate equal to $1\frac{1}{2}$ times the diameter of the rivet; for thin plates up to $\frac{1}{2}$ inch thick, we would recommend for this distance $1\frac{3}{4}$ times the diameter of the rivet for iron and steel plates. 3. What size of rivets or patch bolts are used, and which is preferable, rivets or patch bolts, and why? *A.*—Diameter of rivets for plates $\frac{1}{4}$ inch thick, $\frac{9}{16}$ inch; for plates $\frac{5}{16}$ thick, $\frac{11}{16}$ inch diameter; and for plates $\frac{3}{8}$ inch thick, $\frac{3}{4}$ inch diameter. We prefer rivets, but in some cases it may be impossible to use rivets, under these conditions patch bolts will have to be used. 4. What style of patch, straight, dished with projections towards the fire, or dished with projections towards the water space, is the best? *A.*—We should not dish the patches; if the sheets to which they are applied are straight, then make the patches straight; if the sheets are curved, then give the patches the same curve. We prefer to put the patches in the water space, the advantage of this is that the stress on the bolts or the rivets will be much reduced. There is, however, a disadvantage in placing the patches inside of the water space, namely, it will be difficult to calk them, if not impossible. In all cases the boiler maker must use good judgment, and place the patches so as to prevent them from collecting mud, and put them in the best positions as conditions may allow. 5. To what depth should the holes for rivets or patch bolts be countersunk, and what bevel would you recommend for the heads of the patch bolts? *A.*—The countersunk should extend to a depth of $\frac{1}{3}$ of the thickness of the sheet. For a $\frac{3}{4}$ bolt the diameter of the countersunk should be $1\frac{1}{2}$ inches in diameter, for other sizes of bolts make the degree of bevel proportional to the above figures.

(126) F. N., Sanborn, N. D., writes: I am going to put up a few grain elevators; kindly inform me how fast per minute the belt should run to give the best results. *A.*—About 420 feet per minute. 2. We have a pump worked from the crosshead of our engine; we wish to dispense with this pump and use an injector, and drive the feed water through the heater; can this be done, and will there be any gain in fuel? *A.*—You can feed the water from an injector through a heater, provided the heater is a suitable one, and strong enough for the purpose. All the connection between injector and boiler should be amply large and direct. The efficiency of an injector when compared with a pump is shown in the following table, deduced by D. S. Jacobus, M. E., from experiments:

Temperature of feed water as delivered to the pump or to the injector, 60° F. Rate of evaporation of the boiler 10 pounds of water per pound of coal from and at 212° F.	Relative amount of coal required per unit of time.	Saving of fuel (per cent)
Direct-acting pump feeding water at 60° F., without a heater	1.000	0.0
Injector feeding water at 150° without a heater	0.985	1.5
Injector feeding water through a heater in which the temperature is raised from 150° to 200° F.	0.938	6.2
Direct-acting pump feeding water through a heater in which the temperature is raised from 60° to 200° F.	0.879	12.1

(127) M. H., St. Louis, Mo., writes: I should be pleased to have you solve the following problem, which came up in practice a few days ago: In the accompanying sketch the line $c\ d$ is perpendicular to the radius $o\ c$, the arc $c\ e$ is tangent to $c\ d$ at c,



and is 1,000 feet long, and the vertical hight h is 400 feet; it is required to find the length r of the radius. *A.*—The angle Θ and radius r can be found approximately by the following method; first find the chord A of double the angle Θ by the following formula:

$$A = \tfrac{1}{5}\, L + \sqrt{\tfrac{16}{25}\, L^2 - \tfrac{64}{15}\, h^2},$$

in which A = length of chord of double the arc, L = length of double the given arc, and h = the hight of this arc, as indicated in the sketch. From the above formula we get for the length of A = 1,770.15 feet. The next step will be to find the chord a of one-half the arc of 2,000 feet by the following formula:

$$\sqrt{\left(\frac{A}{2}\right)^2 + h^2} = a; \qquad (2)$$

from this we get a = 971.26 feet. The data as found above will now enable us to find the radius from the following formula:

$$\frac{a^2}{2\,h} = r. \qquad (3)$$

This gives us 1,179.18 feet for the radius. The sine of Θ is equal to $\frac{\frac{1}{2}\,A}{r} = .7505$, which corresponds to angle of 48° 39′ nearly. It should be remembered that these results are close approximations only, the radius as found above is a little too great, but will probably be near enough for your purpose. The above method gives very close results when twice the angle Θ does not exceed 30 degrees.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 252.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Patents, H. F. Parker, Att'y, 26 Cort'ndt St., N.Y.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

70 Uses of Compressed Air mailed free. Clayton Air Compressor Works, 28 Cortlandt street, N. Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Emery, emery wheels, grinding machines and grinders' supplies, quick process and large stock. When in a hurry, buy of The Tanite Co., New York City, Cincinnati, Ohio, and Stroudsburg, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

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Small Gas Engines—Firing Bituminous Coal.

BY W. H. BOOTH.

I have received several inquiries as to the small gas engine with which I was so much impressed. It was the Dawson engine. The Day gas engine is also, I believe, a most interesting engine, and only requires to be started in rotation in the desired direction to continue to so run. It is thus a reversible engine, according as it is started. The office of the Dawson engine is in Queen Victoria street. But it is in large as well as in small gas engines that considerable progress is being made, both in the engine and in gas producers for supplying them. A gas producer on quite a new system of operation was recently described in a French technical paper, *L'Energie Electrique*. In place of being operated as previous gas producers all have been by the forcing of air and steam through a mass of incandescent carbon, the Bénier producer is operated by suction. The engine draws in its supply of gas from the producer, and thus provides the only cause of action, air flowing into the producer just as gas is drawn out of it. So long as the size of the producer is in fair relation to the demands of the engine the results are very good, and there cannot be any excessive gas production, as may occur with a producer actuated by a fan or blower. In some of the tests that were quoted, it appeared, however, that the mechanical efficiency of the engine was only .53; the large difference of .47 being absorbed by the friction of the engine and the air and gas pumps, and it seems possible that the gas pump might have been a cause of some of the high resistance by reason of too great resistance of the producer. The working piston had a diameter of 300 millimeters and a stroke of 439 milli-

meters, the gas and air-compressor pumps having a diameter of 290 and 400, and a stroke of 209, but in spite of the low mechanical efficiency, as shown on a brake, the consumption of coke per effective (French) horse-power hour was only .752 kilos., or less than 1¾ pounds per Watt horse-power. It is pointed out as an advantage of the method of working gas producers by aspiration, that there is no escape of the poisonous carbon monoxide gas, such as may so easily occur with ordinary forms. That great French authority on gas engines, M. Witz, considers this new system to be sound and good, probably only requiring to be rendered a little more efficient. Not only here, but also in France, gas engines are growing larger, and gas producers for generating what the French term poor gas, to distinguish from light-giving gas, are neater, cleaner and simpler, and, what is more, they will work with bituminous coal and yet produce fixed gases free from depositing substances; simply a saw-dust filter being required to take out dust or other accidental impurity that would damage the engine.

The problem of underfiring of bituminous coal, that has so long been held by many as the only means of smokelessly consuming such coal, is completely solved in certain gas producers in which the coal is placed above a column of incandescent fuel, and the gases produced are drawn downwards. The success of the duplex system of producer in which fuel is fed at the top, air is admitted at the base of one vessel, and gas drawn off at the base of the other, the two vessels being joined by a trunk at their upper ends, and the travel of the gas reversed by an automatic valve at frequent intervals, so that each vessel in turn takes in air or delivers gas, should, I think, point out what is needful in the underfiring system, however carried out, namely, a thick bed of fuel. In even a small gas producer the hydrocarbon gas, given off from bituminous fuel, must travel several feet down the column of coked stuff beneath the firing door, and the bright incandescence of this column is secured in the duplex system by the frequent reversals, the vessel in which air enters becoming, of course, the hotter vessel. Could we stoke a boiler furnace from beneath, there would be two difficulties to deal with: First, being below the fire, the underlying stratum of green fuel might be slow to burn, for it would be cooled by the admission through it of the air supply; and, secondly, even if successful, the fire would become choked by dirt and dust. In the gas producer the fresh fuel is placed above the hot fire, and as the fuel cokes it falls to the lower part of the producer cylinder, and packing of the fire too closely is prevented by its continued movement, the coke finally disappearing, and the clinker and dust being raked out from the bottom, which is solid, through a water-sealed opening, the water by its evaporation giving to the gas produced the steam of which it stands in need. Such a system of underfiring is easily managed because the so-called under side as regards direction of draft is really the upper side of the fire. The fuel is coked by the heat of the fire and by the heat coming over from the twin vessel, and the gas is "fixed" in character by its subsequent passage through the thick bed of fire, and subsequently burned in the engine. In gas thus produced, however, there is a loss. The first oxidation of a pound of pure carbon is accompanied by an evolution of heat to the extent of 4,400 units. This is when carbon is burned to monoxide. But if we take this gas produced from one pound of solid carbon and burn it to the dioxide form of carbon, we find that it now gives off 10,100 heat units, and we are thus taught that an atom of oxygen combines in one case with an evolution of over double the amount of heat produced by the combination of the first atom of oxygen. There is in fact a difference of 5,700 units. But this can be explained. When a solid becomes liquid, heat disappears. We may mix ice at 32° Fahr. with a certain proportion of water at 200° Fahr., and yet the mixture has still a temperature of only 32° Fahr. This is because the apparent or sensible heat has become hidden in the water for the ice has disappeared. Exactly the same occurs with steam. Add heat to water at 212 degrees and the steam produced in an open vessel is still only at 212 degrees temperature. In burning carbon, either as coke or anthracite or any other form, we have to change it at one operation from a solid to a gaseous form, and in so doing we render latent both the heat necessary to liquefy carbon and that necessary to evaporate it. These operations cannot be performed on carbon alone unless possibly they might be proved to take place in the crater of an arc lamp carbon, but in combination with oxygen carbon becomes a gas, and the latent heat of vaporization is absorbed all the same, and may be assumed as 5,700 units per pound, or the difference between the sensible heat produced by the first and second oxidations.

In gas-producer work it is usual to pass the gas through coolers, and to store it in a holder, and the bulk of the 4,400 units produced in the process are radiated to the atmosphere. It is obvious, therefore, that in the Bénier apparatus the quick and direct use of the gas ought to prove an economy if the dilatation of the bulk of the gas be not an obstacle in its use so hot, and where cooling pipes are employed, it follows that the air flowing to the producer might be made to take up heat from these pipes.

If it were not for the large amount of nitrogen in air, the great excess of air used in a gas engine, beyond that necessary for combustion, would render it possible to save some of the heat that now goes to waste in the exhaust by turning a portion of the exhaust back through the producer, thus reconverting the carbonic acid to monoxide, and saving the heat otherwise thrown away. The gradual accumulation of nitrogen prevents this economy being attempted. But it is clear that so long as we reject the 4,400 heat units produced when we make producer gas, we are throwing away at the outset nearly a third of our fuel. In the steam boiler we do not do this. We get all the heat of combustion in the furnace, but we sent about a third of it up the chimney. In the steam boiler, too, we dilute the temperature by using from fifty to one hundred per cent. more air than necessary. This is a serious loss of efficiency. In the gas engine the same thing is done by using an excess of air in the cylinder, and in the gas engine we put a cold jacket round the cylinder, and at one stroke reduce the efficiency by one-half, because we have no means yet available of using the gas at the temperature of combustion. Thus it is that the efficiency of the gas engine is so much less than it could be made for a few minutes. But the steam engine works always at its highest possible efficiency, if we will allow it, and in this it differs from the gas engine, which requires to be curbed. In other words, we cannot see ahead any serious augmentation of the efficiency of steam, whereas the gas engine is working at half effect only, and we all know it. But the time will come when we shall not be obliged thus to waste its energy, and anything over ¾ pound of fuel per horse-power hour will be thought wasteful.

London, England.

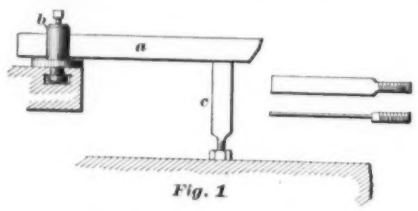


Fig. 1

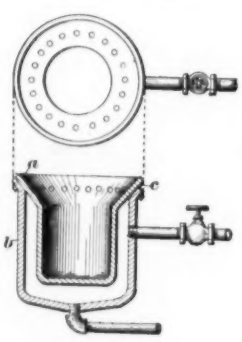


Fig. 2

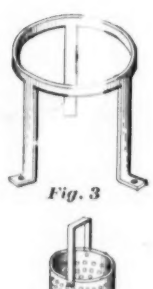


Fig. 3

Fig. 4

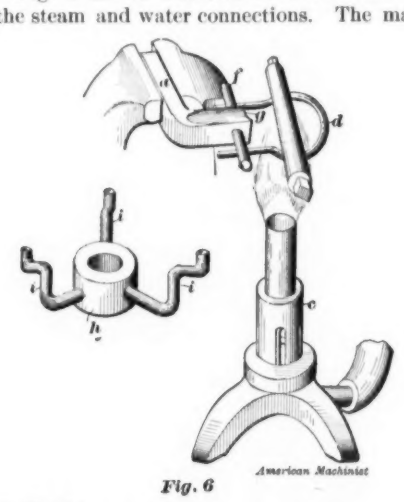


Fig. 6

Some Handy Tools.

A Handy Lathe Tool—A Good Soda Kettle—A Tool-room Combination.

By James F. Hobart.

A very handy rig for supporting a lathe tool when taking a deep cut is shown by Fig. 1. The tool *a* is supported in the tool post *b* in the usual manner. A support *c* is placed under the tool, near the cutting end, as shown in the engraving. The nut at the lower part of *c* permits of a slight adjustment in length of support, sufficient to make it fit tightly between the slide rest and the tool. This rest is almost a necessity when cutting off large iron castings, and it can also be used to advantage in all face-up work of large diameter. Its simplicity is its best recommendation.

I was in Mr. Brady's shop the other day and heard a compliment paid to the proprietor which deserves mention. For many years he has been familiarly known as Jim Brady among his friends. Upon this occasion one gentleman referred to him as Jig Brady. To everyone of his acquaintance the peculiar fitness of the name will be apparent—Mr. Brady's inclination to jigs for doing nearly all kinds of work being known and appreciated by the trade generally. It is in his shop that a soda kettle is located which will be described.

Fig. 2 shows a section of the kettle and the steam and water connections. The material is cast-iron. The inner shell of kettle proper *a* and the outer shell *b* were both swept up in a venture without any pattern being made. The metal is thick enough to stand 60 or 70 pounds of steam. The vessel is made flaring at the top as shown for two purposes: to make it easy to form the joint *c*, also to form a flaring dish that both liquids and solids may be easily placed in the kettle.

Fig. 3 shows the stand which supports the kettle. It is made of bar-iron about ¼ inch thick and 2 inches wide. The four parts are riveted and welded up as shown. When used on small work, the articles to be treated are placed in the strainer, Fig. 4. This is made of heavy galvanized iron perforated as shown, the bail being riveted on and made long enough to project quite a distance above the kettle, so that there will be no danger of being scalded by steam when removing the contents.

A tool maker in a large shop, Mr. F. W. Hamlin, B. & A. Locomotive Repair Shop, Boston, favors the writer with the following ideas: Fig. 6 shows a handy rig got up for heating soldering irons, taps, dies or any small pieces of steel. The tool holder *a* is made of iron as shown, and when used is held in a vise. The Bunsen burner used in connection with this apparatus is a little different from ordinary Bunsen burners inasmuch as the shell *c* slides up and down to regulate the flow of air, instead of turning round as is usual with this class of machine. The burner is placed underneath the wire loop *d* which supports the work. The loop passes through holes drilled in the pin *f*. By removing the wire loop the tool holder can be made to support a soldering iron, the shank of the iron being placed in the hollowed out space shown at *g*.

Another part of the Bunsen burner is sketched at *h*. This part is made to fit on over the top of the burner *i*, and when in place forms an excellent support for any vessel in which it is desired to heat water—or coffee, for instance.

Modern Furnace vs. Cupola Practice.

By Thos. D. West.

Improvements in blast furnace practice have resulted in an economy and general advanced practice far surpassing foundry cupola practice. Great importance is attached to the shape of a furnace lining. There is no end to the different angles, etc., given to furnaces; each style having its advocate, until at last we have Hawden and Howsen, of Middleborough, England, who are using and advocating the plan of turning present forms upside down. When experienced furnacemen thus disagree, it is but fitting for a foundryman in explaining the construction, etc., of a blast furnace to present its principles and ideas as related to cupola practice.

At the present time the writer is managing a foundry which is surrounded by several furnaces, and is but about 300 feet from a concern that has torn down a furnace and just erected a modern one of larger capacity, which is making about 175 tons of iron every 24 hours. As this is an old established concern, and its managers are men of long experience, I have asked the privilege of illustrating the general principle and outline of their furnace, as seen at Figs. 1 and 2, and will use this in aiding me to compare furnace with cupola practice. The reason for the furnace being contracted at the hearth, or that portion containing its tuyeres, is mainly to aid the blast in reaching the center of the furnace, and cause a more even distribution of its pressure throughout the fuel. There are some who advocate building the hearth of a furnace but a foot or two smaller than the largest diameter at the bosh, claiming that it soon burns out if made much smaller; but to judge from my observation and inquiry from many experienced furnacemen, the form of hearth shown is best, as such a form can be well maintained through a long service by reason of a good system of water coolers keeping the outside of the hearth cool, and lowering the temperature of all the area subjected to heat. It is also claimed that such a form not only aids the blast to reach the center, but the "batter" or bevel of such a bosh as shown assists in supporting the weight of stock charged, thus lessening pressure at the tap hole, permitting the metal to be under better control, with less liability to cut the breast as the metal flows out to the runner. When such a sized furnace as shown is full of stock (coke, ore and lime) the weight bearing down on the hearth when a furnace is working properly is something like 100 tons of coke, 160 tons of ore, and 35 tons of lime, a total of about 300 tons. Such a weight must be very effective in crushing the almost fusible stock in the reduced body of the bosh so as to greatly retard the penetration of blast, and be one reason for the high pressure found necessary in furnace practice.

Gradually decreasing the diameter of the stack from its larger portion joining the bosh up to the top, is mainly to assist in preventing the stock from "scaffolding," which in foundry practice means "hanging up." This, as all founders know, is generally due to iron charged forming a wedge to block itself from descending, acting as it were like the key-stone of an arch, which if once loosened permits the whole structure to fall. In the furnace "scaffolding" is more due to a layer of stock being fused to a solid union from the effects of the heat, reducing it first to a mushy, half molten state on its movement downward to the

fusing point, which is said to range from one to four feet above the tuyeres. When furnacemen experience trouble with "scaffolding," they often resort to the use of more fuel than when all is working well. The additional percentage of fuel causes a greater heat in the reduction zones, making the stock more plastic, preventing a solid union, and making it give away easier from the walls of the furnace. It takes about fourteen hours for stock to work down from the top to be tapped out as iron.

The "scaffolding" of a furnace is a very common affair, and one which often results disastrously. I have seen a "slip" cause such an explosion as to lift up the "bell" and "hopper" *F* and *K*, throwing them out almost on top of the furnace platform, and straining all parts to such an extent that it was a question if the furnace shell was safe to be relied upon. I have heard of the bell and hopper being blown about 20 feet from a furnace. Within the last year plans have been adopted to relieve sudden gas pressure, some of which are working very satisfactorily, especially the system used on the furnace joining our foundry, and designed and patented by Mr. P. C. Reed, the furnace superintendent, and shown in Fig. 1. The idea is to build four large openings equally divided around the circumference, and within a few feet of the top of the stack, having these connected with flues branching upward about 8 feet high, and closed by means of valves hung on pivots, as seen at *H H*, Fig. 1, and so regulated by weight that they will open themselves when any excess of ordinary pressure is created in the furnace. This late improvement is a step forward in furnace practice which greatly diminishes the risk of accidents and loss of life, but it still remains to better guard against the evils of scaffolding or the slipping of stock, so detrimental to successful furnacing, and which often requires several days after a slip to get a furnace back again to satisfactory working. A "slip" in a furnace often means the falling of from 25 to 200 tons of stock, a hight of from 1 to 10 feet. The contemplation of this taking place within a furnace filled with combustible gases, heated stock and liquid metal, should enable a man to form some conception of the damage that could be done, and the reason why all hands working around the furnace have good cause to fear a slip. The "scaffolding" of stock can take place at most any portion or hight of a furnace, and can prove so disastrous as to disable or make unsafe the working parts of a furnace. In such cases the blast is shut off until necessary repairs are made, and which if of an elaborate nature may often call for the "blowing out" of a furnace.

The reason for stock "scaffolding" in the furnace is chiefly due to irregularity in the lining. The constant friction of the stock in working downward cuts cavities into the lining, often forming regular shelves upon which the stock can easily hang up. The longer a furnace runs, the more favorable it becomes to scaffolding, and when we are told that ore is an element to first become gummy and plastic before it melts to a fluid state, the founder can readily perceive why much trouble can be expected from "scaffolding" and "slips" in a furnace, causing an irregularity in the product, and disarranging all calculations of the furnace manager in obtaining the character of iron desired. These conditions should enable the founder to perceive that relying on any special brand being always the same from any furnace is a very uncertain reliance. If it were not possible for such "slips" or "scaffolding" to occur, the greatest risks, difficulty and worry in managing a furnace might be said to be removed.

CONSTRUCTION OF TUYERES AND PROTECTION TO LINING.

At *B*, Fig. 2, are shown ideas involved in the construction and principle of furnace tuyeres. For the size of furnace shown, eight tuyeres are evenly divided around the circumference, and project from 6 to 10 inches beyond the lining, for the purpose of aiding the blast to reach the center, and assist in preventing tuyeres "bunging up," as the farther in beyond the walls of the hearth such tuyeres can project, the greater the heat to prevent chilling at the end of the tuyere. This also protects the lining. It is claimed that a tuyere protruding no farther than the face of the lining would rapidly cut out the brickwork at that point. I believe there is much importance to be attached to this method, for in my experience with cupola work, I have found, by experimenting with tuyeres protruding into the cupola with a design of bringing the blast pressure more to the center, that the lining was not burned out nearly so rapidly as with the tuyere's face even with the lining, as is the general practice. From a study of this principle in furnace practice, it would seem that a water tuyere inserted into a cupola on the plan of a furnace should be very beneficial in preserving the lining. This idea, for those founders who have a class of work very destructive to linings, is one not to be ignored.

These furnace tuyeres are made of an alloy chiefly composed of copper so as to approach a bronze metal. This class of metal has been found the best to prevent the melted iron, as it drops down, from adhering to or clogging around the tuyeres, which, if it should occur, would be very troublesome and liable to cause much damage. When tuyeres are found leaking it becomes necessary to pull them out and replace them

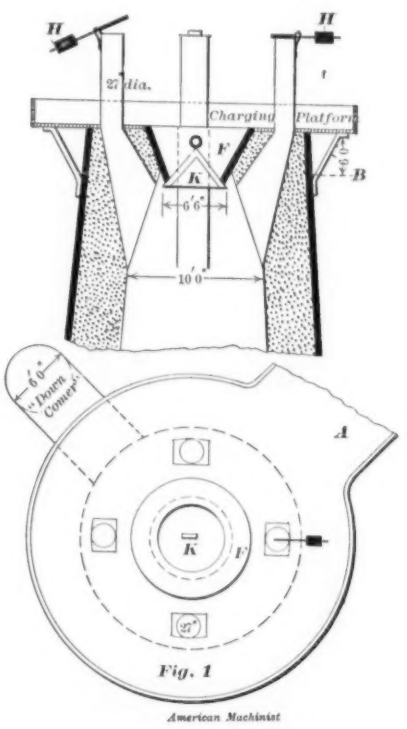


Fig. 1

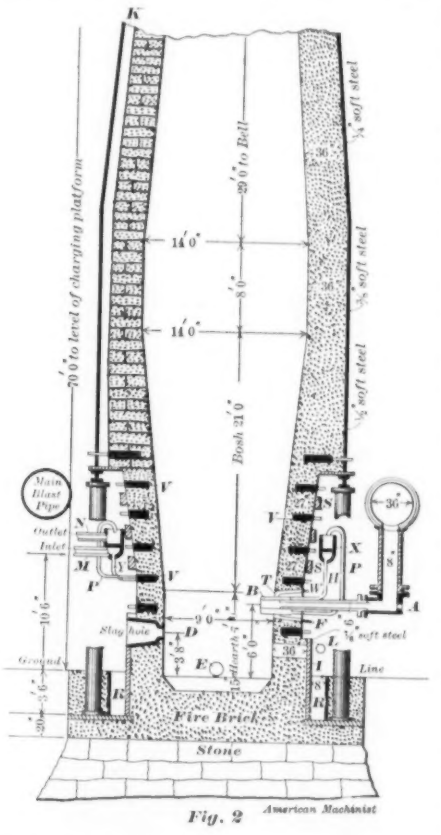


Fig. 2

FURNACE VS. CUPOLA PRACTICE.

with new ones, which are always previously tested by water pressure to learn if they are sound. There are several ways a furnaceman can tell if water is leaking into his furnace. The plan generally followed to first locate a leak, is to insert a rod of iron through a peep hole *A*. If upon withdrawal moisture is found on it, leakage is then known to exist. The plainest evidence of a large leakage is an excess of gas in the hot-blast oven, by some called "wild gas," or by steam escaping outward from the furnace at the point of leakage, or, third, by the fact that the iron produced is up in sulphur; and often, instead of the furnace producing a No. 1 iron as desired, it may range from a No. 2 up to "white iron." To prevent these tuyeres from melting or burning away from exposure to the heat of the fuel and hot blast, a constant stream of cold water flows through them, going in at *H*, and coming out at *F*. Often through irregular workings, tuyeres may become bunged up as in cupola practice, and the method generally followed to open them, is to shut off the blast and endeavor to knock a hole through the chilled material, after which the hot blast (of about 900 degrees heat) with its high pressure, which ranges from 4 to 10 pounds, instead of 8 to 16 ounces as in cupola practice, will generally cut or burn away the chilled material fronting the tuyeres. Should this fail, the blast is shut off and the tuyere is pulled out, thereby leaving a big hole to work through, and by means of sledges and steel bars an opening is cut into the furnace and the cold, chilled debris pulled backward out of it. In replacing such a tuyere, a large lump of clay is pushed forward into the face of the hole, and then the tuyere is pressed or knocked inward against the pressure of the stock in the furnace until it is in its right place. After this is done any clay that might block up the hole in the tuyere to prevent blast to the furnace is broken away by means of a bar, and after the water pipes are attached, the blast is again put on. The reason for first pressing the lump of clay into the furnace before inserting the tuyere is for the purpose of protecting the tuyere from the melting heat of the furnace until it can be properly replaced and water attachments reliably made. The removal or insertion of furnace tuyeres is an operation very readily performed owing to the taper seen in the stationary sleeve at *T*, Fig. 2. This stationary tuyere support is cast hollow, of the same metal as the tuyere proper, and is kept cool by a flow of water going in at *W* and coming out at *F*. It is very rare that one of these sleeves is required to be removed, as they do not project into the furnace, as is the case with the tuyere proper.

It is very important in furnace construction to provide means to keep it cool, as this is a necessity to long continued running. Some furnaces are better provided with cooling appliances than others. In the furnace shown water is admitted to a suspended cast-iron receiver (as seen at *X*) which encircles the furnace, excepting an opening of about two feet at the front or breast side of the furnace. The cold water is admitted to this receiver in its lower division at *M*, and after having done its work it flows into the upper division and is carried off through the waste pipe *N*. The pipes marked *Y* are those admitting the cold water to the coolers, and *P* those returning the heated water to the waste receiver. At *V V V* are seen some of the many coolers which are built in the furnace lining to preserve its life. In the furnace shown these are laid in layers about 30 inches apart in hight, and has about two feet of space between them. Some furnaces have them built much closer than this, both in hight and circumference. There are various different plans of coolers used with furnaces. The coolers here illustrated are made of cast-iron about three inches thick by two feet square, and each has three independent coils of one and one-half-inch pipe cast in it, so arranged that should the front coil be attacked by the heat as it burns out the lining, it can be shut off, and the inner coils be made operative independently or as a whole. Some furnaces have these coolers made of bronze, cast hollow. It is very seldom trouble is experienced with the coolers shown, and if any should occur, arrangements permit their being taken out and replaced. At *L* is seen a two-inch pipe, perforated with one-eighth inch holes about two inches apart, which encircles the furnace and keeps a constant stream of cool water running down the plate *I* which supports the hearth portion of the furnace. This water runs down on the outer surface of the plate to a reservoir *R*, which can be let fill up with water to a hight of three feet, should it be found necessary to protect the lower portion of the hearth with a heavy body of water. A valve is so arranged in this lower reservoir *R* that any hight of water can be maintained. It is no unusual occurrence for the metal to break out at this portion of a furnace, resulting in much danger to property and life. The furnaceman's lot is by no means one the founder need envy, for he shares very fairly the troubles and dangers he has who "meddles with hot iron."

At this point I would call the founder's attention to the fact of no boiler casings or shell being used to support that portion of the hearth and bosh which inclose the tuyeres and water coolers *V*.

This portion of the furnace has its firebrick work supported only by means of wrought-iron bands, six inches wide by one inch thick, which encircle this portion at the hight of every two feet as seen at *S*. The idea of not encasing this part with solid boiler plates riveted together, as is done with the balance of the furnace, is so as to permit this portion of the furnace brickwork to be exposed to the cooling of the atmosphere all that is possible. It is at this unprotected part of the bosh and hearth that the lining is subjected to the greatest heat, and hence the reason for the arrangement of coolers and exposure of the outer surface of the lining as has been described. I have every reason to believe that attention will be paid by many founders in a few years to the matter of providing arrangements for protecting the "melting point" of a cupola, and the principles herein described cannot but be of much assistance in aiding to form ideas for such appliances. While there are specialties in founding that these ideas will be of little or no value for, still we have, even at the present day, some that could well use such appliances for keeping cool the "melting point" to good advantage. There is a tendency in some lines to attain continuous melting, and with such these ideas cannot but be of value. As an amusing incident, the writer some time back witnessed a heat being run in which three men with buckets and one with a hose were throwing water on a cupola shell to keep it from burning out, until sufficient iron could be melted for a big casting which was to be poured. Had this founder been aware of blast furnace practice, he no doubt would feel like utilizing some of its cooling appliances as a labor-saving device, should he have another heat under the same conditions.

Machine Wipers of Raw Silk.

Machine wipers, made of raw silk, are being introduced by a Philadelphia silk manufacturer, and it is claimed that they are the best thing yet used for that purpose, chiefly because they are entirely free from danger of spontaneous combustion, and leave no fibers or shreds adhering to machines on which they are used. A special compound is furnished for cleansing them, and their cost is said to compare very favorably with any other cleaning implement.

It is our intention to publish in next week's issue, some account of the life and work of Frederick E. Sickels. This will be illustrated upon a liberal scale, and eminent engineers will take part in its preparation. Mr. Chas. T. Porter contributes some very valuable and very interesting historical facts to this account.

NEW CATALOGS.

We have received from Perry Ransom, Oshkosh, Wis., a catalog of polishing and buffing machines, in which illustrations and descriptions of a line of such machinery are given.

We have received from Henion & Hubbell, 61 North Jefferson street, Chicago, Ill., a special mill pump circular, illustrating and describing belt and electrically driven pumps of various forms for paper makers and other uses.

The Deane Steam Pump Co., Holyoke, Mass., have issued a number of small pamphlets, each devoted to some special type of pump made by that company. They include a great variety of pumping machinery, and are sent on application.

We have received from the Baldwinsville Centrifugal Pump Works, 715-723 West Fayette street, Syracuse, N. Y., "Catalog C," which describes and illustrates centrifugal and triplex pumping machinery, together with pipes, fittings, valves, etc., used with such machinery.

We have received from W. H. Ermentrout, Reading, Pa., a catalog illustrating and describing special machinery made by him for finishing hats. There are engravings also of planer chucks of novel construction, and also some drill presses, polishing and buffing machines, etc.

The Hilles & Jones Co., Wilmington, Del., have issued a supplementary catalog of the special line of machine tools built by them, which includes punches and shears of various forms driven by belts, engines and electric motors; there are also illustrations and descriptions of plate-bending rolls, straightening rolls, and vertical milling machines.

We have received from the Q. & C. Co., 703-706 Western Union Building, Chicago, Ill., an illustrated catalog of machinery for cold-sawing metals. It contains much useful information on this subject, and will well repay an inspection, especially by those who have given little attention to this method of working metals. It is standard size (6"x9").

We have received from Wells Bros. & Co., Greenfield, Mass., a catalog of screw cutting tools and machinery, which includes taps and dies, die stocks of various kinds, dies for use in the screw machine, hand and power-driven machinery for bolt cutting, nut tapping, etc. There are also illustrations of other machines, designed especially for blacksmiths' use. It is standard size, 6"x9".

We have received from the Mason Regulator Co., 10 Central street, Boston, Mass., a small price list and catalog of steam-regulating devices manufactured by them. It is illustrated with perspective and sectional engravings of the various devices which have been brought out by this company, and will, of course, be found of interest to all who have to do with steam plants. It is sent, upon application, to any address.

MANUFACTURING.

The Great Northern Railway is to be extended to Victoria, B. C.

It is said that the Weymouth and Braintree (Mass.) Street Railway line will be extended.

The Pendleton Ground Mining Co., of Gardiner, Maine, will build a mill this spring.

The Duncombe Stucco Mills, at Fort Dodge, Ia., destroyed by fire recently, will be rebuilt.

The Lancaster (Mass.) Slate Co. is going to erect additions to its plant in the coming spring.

The Spearman furnace in Sharpsville, Pa., will be rebuilt as soon as the weather will permit.

It is said that the Junction Iron and Steel Company will erect a new plant at Mingo, Ohio.

The Gurdon Lumber Co., of Gurdon, Ark., have in contemplation the rebuilding of their mill.

The Lyman Corporation, of Holyoke, Mass., will build a new mill. It will be 296 by 96 feet, and will be five stories high.

A company is being organized to build an electric line from Toledo to Sylvania, Ohio. George W. Acker, of Toledo, Ohio, is interested.

The Westinghouse Air-brake Works, of Wilmerding, Pa., has resumed operations in its shops, and 3,000 men will be given employment.

The new plant of the Western Iron and Steel Company, at Lake View, Wash., has just been completed, and is now ready for operation.

The Wheeler-Sterling Co., of McKeesport. Pa., has decided to increase the capacity of its plant, and work has commenced on a new rolling-mill.

The Bennington & Woodford (Vt.) Electric Railroad Company propose to construct an electric road to run from Camp Comfort to Bennington.

The Saginaw (Mich.) Clay Mfg. Co. has purchased the Latterson mill site, on which it will locate its plant. The work on the new plant will commence soon.

The Locomotive Valve Gear Co., of St. Louis, Mo., has been organized, with a capital stock of $50,000, by W. J. Lewis and B. F. Clark, who will erect a plant.

A street railway will be built at Batavia, N. Y. The work on the road will commence as soon as the weather will permit. Mr. Wilgus is president of the enterprise.

I. L. Ellwood, of Sycamore, Ill., has announced that the Chicago Great Western Railroad will build a track from Sycamore to DeKalb, Ill., within the next three months.

The York (Pa.) Mfg. Co. have decided to immediately commence the erection of a large plant at the juncture of West York avenue and the Western Maryland Railroad.

Arrangements are being made to construct a trolley road from Port Jefferson to Patchogue, Long Island, N. Y. T. W. Fanning and Capt. J. L. Tooker, of Port Jefferson, are interested.

The Yankton (S. D.) Electric and Mfg. Co. has been organized, with a capital stock of $40,000. The organizers are John McGregor, R. B. McGregor, Otto R. Brandt, F. H. Evans, and George Comling.

A syndicate of Boston capitalists have purchased the horse car street railway line at Parkersburg, W. Va., and will convert it into an electric line. Work will be commenced on the new road in a very short time.

The Solvay Process Co., of Syracuse, N. Y., has purchased a tract of land in Detroit, for which they are said to have paid $210,000. On this land it is proposed to build a new manufacturing plant, which will be a branch of the establishment at Syracuse.

The Armstrong Bros. Tool Co., Chicago, Ill. write us that business is good with them, and that they recently shipped two dozen of their Armstrong boring tools to Russia upon an order received through their advertisement in the American Machinist.

The Carpentersville, Elgin & Aurora Railroad Company, which has just been incorporated, propose to construct a railroad from Dundee to Aurora, Ill. The incorporators are A. B. Church, D. B. Sherwood, Wm. Grote, James B. Lane, E. Dunbar Waldron, and George M. Peck, all of Elgin, Ill.

The Bonta Plate Glass Co., of Scranton, Pa., has placed the contract for its new building with the Berlin Iron Bridge Co., of East Berlin, Conn. The building will be 140 feet wide and 1,144 feet long, covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof covering.

The new power plant for the Nassau Electric Co., at South Brooklyn, N. Y., is fully completed. This building was designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn. The engine and dynamo room is 58 feet wide and 150 feet long, equipped with a 13-ton crane having a travel the full length of the building. This portion of the plant is covered with the Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof lining. The boiler room is 47 feet in width and of the same length as the engine and dynamo room, and is so arranged that 2,000 tons of coal can be stored in the pockets. The entire construction is of iron, and the buildings, when completed, will be fire-proof.

Machinists' Supplies and Iron.

New York, March 23, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $11 to $12 for No. 2, and $10.50 to $11 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.25 to $11 for No. 2; $10 to $10.50 for No. 3; $10.50 to $10.75 for No. 1 soft; $10.25 to $10.75 for No. 2 soft; and Foundry No. 4, $9.50 to $10.

REDUCING VALVES

For reducing and maintaining an even steam, air or water pressure. These valves have been on the market for years, and are used by all the best and largest steam plants of the world.

MASON REGULATOR CO., Boston, Mass.

BUFFALO VENTILATING FANS
ELECTRIC, STEAM AND PULLEY TYPES, GREATEST AIR VOLUME, LEAST POWER
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

Chicago Office, 22 and 24 West Randolph Street.

PROGRESSIVE AND APARTMENT TYPES
BUFFALO LUMBER DRY KILNS.
BUFFALO FORGE CO. BUFFALO, N.Y. U.S.A.

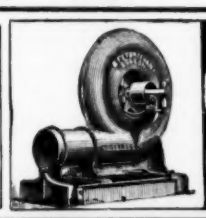
ELEMENTARY • MECHANICS.
BY E. S. DANA.
12mo Cloth, $1.50.
JOHN WILEY & SONS, NEW YORK.
See American Machinist, March 21, page 226.

GRANT GEARS
Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St., Philadelphia, Pa.,
and 86 Seneca St., Cleveland, Ohio.

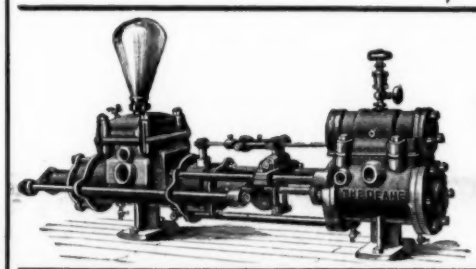
CLOUGH'S DUPLEX GEAR CUTTER.

One pair cuts from 12 teeth (and all intermediate sizes) to a Rack. For jobbing and experimental work the best. 16 P. and finer can be made to mill off tops of teeth. Kept in stock and shipped promptly. Special work to order.
Send for Circular.
R. M. CLOUGH,
TOLLAND, CONN.

THE STURTEVANT PORTABLE FORGES
ALL SIZES & STYLES
SEND FOR CATALOGUES TO
B.F. STURTEVANT CO. BOSTON MASS
NEW YORK, PHILADELPHIA, CHICAGO, LONDON


THE STURTEVANT PRESSURE BLOWERS
ALL SIZES & STYLES
SEND FOR CATALOGUES
B.F. STURTEVANT CO.
BOSTON, MASS.
NEW YORK, PHILA. CHICAGO, LONDON

BORING AND TURNING MILLS
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.
We have a variety of sizes and a large stock for immediate shipment.
THE BULLARD MACHINE TOOL CO.,
E. P. BULLARD, Pres't. BRIDGEPORT, CONN.
New York Office, 86 LIBERTY STREET.

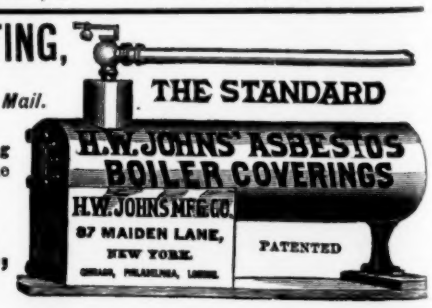

THE DEANE
OF HOLYOKE
BOILER FEED PUMPS,
PISTON OR PLUNGER PATTERN.
THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.
SEND FOR "THE DEANE SPECIALTIES."

Crescent Steel Co.
PITTSBURGH, PA.
CHICAGO, ILL.
NEW YORK, N. Y.
Crescent Extra
. . IS . .
The Best Steel you can get anywhere for Cold Chisels.

THE TAPS PASS CLEAR, MAKING FULL
THROUGH THE NUTS, FINISHED THREADS
THE GREEN RIVER SCREW PLATE
DIES ALWAYS READY TRUE TO SIZE
PERFECT SCREWS AT A SINGLE CUT
FINE SCREW PLATES.
"Lightning" and "Green River."
Taps, Dies, Reamers, Tap Wrenches, Bolt Cutters, Drilling Machines, Punching Presses and other labor saving Tools. Send for Catalogue.
WILEY & RUSSELL MFG. CO., - - Greenfield, Mass.

"R. MUSHET'S SPECIAL STEEL"
SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
Sole Representatives in the United States.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

LATHES! PLANERS!! SHAPERS, &c.!!!
We Were Not Awarded a Medal at the World's Fair,
because our tools were not on exhibition there but our customers write us that every tool built by us has proven exactly as represented. Our claim is that "Our tools are of the latest and most approved designs while the workmanship, material and finish are of the highest order." Our catalogue will tell you all about them. Prices quoted on application. No time like the present to buy!
SEBASTIAN LATHE CO.,
117-119 Culvert St., CINCINNATI, O.

ASBESTOS CEMENT FELTING,
FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
H. W. JOHNS MANUFACTURING CO.,
87 Maiden Lane, NEW YORK.


Antimony—The market is quiet, business improving. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¾c. to 8⅞c.; Hallett's, 7¼c. to 7.20c.; and U. S. French Star, 7⅛c.

Lard Oil—Prime City we quote at 53c. to 54c.

Copper—There is no improvement in the market, but a better feeling prevails. Lake Copper is quoted at 9⅜c. to 9.40c. Casting Copper is held at 9c. to 9⅛c.

Lead—The market is strong, and business decidedly improving, with an advance in prices. Sellers are now asking 3¼c. to 3.15c. for New York delivery.

Spelter—The market continues dull, with scarcely any change in the demand. Sellers quote 3.20c. to 3 22½c. for New York delivery.

Tin—The market shows signs of improvement, but the volume of business is not up to expectations. Holders are asking 13.90c. to 13.95c. for prompt delivery.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Mechanical draftsman, 4 years' prac. experience, tech. education, wants pos. Draftsman, AM. MACH.

Mech. draftsman & engineer wants position; good refs.; N. Y. preferred. BOX 139, AM. MACHINIST.

Agents wanted for a fast-selling boiler-room specialty. Essex Bros. Mfg. Co., Lorain, Ohio.

Draftsman (22), tech. education, 3 years' practical exp., desires change; best refs. Box 144, AM. MACH.

Patternmaker wanted. Address Machinery, P. O. Box 886, New Haven, Conn.

Wanted—Employ't by 1st-class, all-round machinist & tool maker. Address Experienced, AM. MACH.

Draftsman (25) tech. education, 9 years machine shop and drawing office experience, desires pos.; engines or pumps. Box 141, AMERICAN MACHINIST.

Wanted—Mechanical draftsman & designer, one familiar with printing machinery preferred; state age, exp., & salary expected. Box 143, AM. MACH.

Wanted—A situation as draftsman; has had several years experience in marine and gen. engineering work. Address W. B., AM. MACHINIST.

Wanted—Foremanship of machine shop. Experienced, able and energetic. Good references. New York State pref'd; age, 32. "Earnest," AM. MACH.

A first-class man wants position as foreman (or to lay out) in either boiler or gas-holder works; A1 refs. (.0 years' experience). Address Box 124, AMERICAN MACHINIST.

A good machine shop, with new tools and young management, situated near Cincinnati, Ohio, wants to correspond with parties wanting machinery built. Middletown Machine Co., Middletown, Ohio.

Mechanical and electrical engineer, and designer of electric and steam power plants, complete; general machinery and buildings; 12 years' experience, wants position. Box 127, AMERICAN MACHINIST.

A practical man of energy and push desires a change of location. Eight years' experience with large electrical company. Would like to correspond with parties in need of a hustling superintendent. Address Energy, care AM. MACHINIST.

Mechanical engineer, age 30, thoroughly versed in the theory, practice and design of steam and refrigerating mach'y, desires sit. as eng'r or designer, competent to assume complete charge and responsibility of any work in these branches; strictly highest class refs. A. M. B., AM. MACH.

Wanted—A master machinist as foreman of a marine machine shop; he must have had a large experience and practice in shops engaged in building and repairing marine engines; must be proficient in drawing and accustomed and competent to make estimates on such work; pref. would be given to a person between the ages of 30 and 45; applicants may address Master, care of AMER. MACH., giving full reply to above with refs. if practicable.

(*Continued on Page 254.*)

JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &c.

ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

BOHLER'S STYRIAN TOOL STEELS.

First Quality for Shop Tools.
Extra Quality for Expensive Tools.
Special for Boring and Turning Hard Metals.
"BOREAS" SELF-HARDENING.
HOUGHTON & RICHARDS, SOLE AMERICAN AGENTS,
148 & 150 Oliver Street, BOSTON.

C. W. LE COUNT,
SOUTH NORWALK, CONN.

REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.60
4	3-4	.80
5	7-8	.85
6	1	.90
7	1 1-8	.95
8	1 1-4	.95
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.35
Full set of 19		$21.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

This Dog has a Very Heavy Bone, so that if the thread wears a Heavier Screw can be substituted.

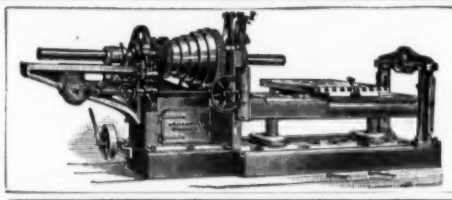
Le Count's Heavy Steel Dog.
With Steel Screws, Lathe Made and Hardened.
When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of those dogs prefer them to any other make.

One Small Set of 8—by 1-4 inches to 20 inch, - - $6.25
One Set of 12—by 1-4 in. to 2 in. continued by 1-2 in. to 4 in. 13.25

These goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

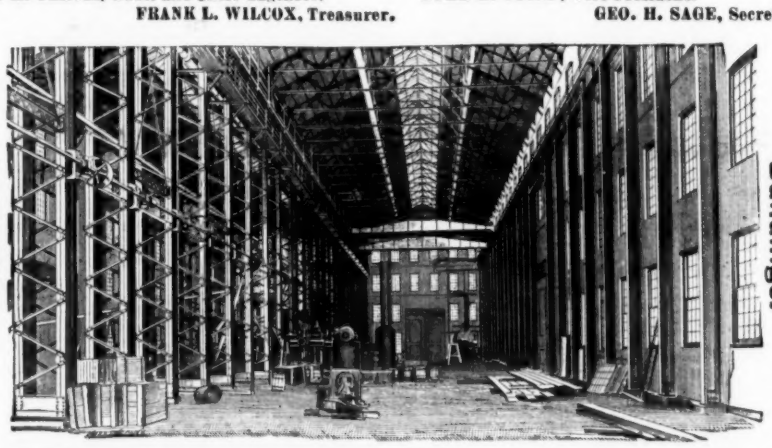
NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000 VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



BETTS MACHINE CO.,
WILMINGTON, DEL.
MACHINE TOOL BUILDERS.
Improved Patterns! Late Designs!

THE BERLIN IRON BRIDGE CO.
Office and Works,
No. 8 Railroad Ave., East Berlin, Conn.
CHAS. M. JARVIS, Pres. and Chief Engineer. BURR K. FIELD, Vice-President.
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of Iron and Steel Bridges and Buildings.



The above material taken direct from a photograph, shows the interior of a Boiler Shop designed and built by us for the Newport News Ship Building and Dry Dock Co., at Newport News, Va. The building is 100 feet in width by 300 feet in length, the width being divided into two parts of 50 feet each, with a row of columns through the center. The entire framework of the building is of iron, with light brick walls around the outside, placed between the iron posts. Hydraulic traveling cranes control the entire floor surface. The building is made very high so as to allow of boilers being removed one over another from one part of the building to the other.

SEND FOR OUR ILLUSTRATED CATALOGUE.

SOFT CASTINGS,
Made from best grades of Pig Iron for Light Machinery, Electric Work, etc.
THE BURR & HOUSTON CO.,
33 TO 39 FRANKLIN ST., BROOKLYN, N. Y.

The Elliott Drill Press
FOR ANY LIGHT WORK.
LARGE RANGE OF WORK—LOW PRICE.

THE ELLIOTT DRILL.

Now Manufactured by
A. J. WILKINSON & CO.,
180 to 188 WASHINGTON ST., BOSTON, MASS.
SEND FOR CATALOGUE.

THE BEST MECHANICS USE
MY VERNIER CALIPERS.
Ask your Dealer for them, or send for Catalogue and Special Prices to
E. G. SMITH, Columbia, Pa.

Star Lathes
Foot power
Screw Cutting
Automatic
Cross Feed
9 and 12 inch Swing.
New Designs. Novel Features.
Send for Catalogue B.
SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N. Y.

THE INGERSOLL MILLING MACHINE CO.,
ROCKFORD, ILL. U. S. A.
P. O. Box 3,450.

INGERSOLL PATENT MILLING CUTTERS
Pat. Dec. 24, 1889. of any size or form.
See AMERICAN MACHINIST, March 21, 1895, page 236.

FITCHBURG TOOLS.
LARGE LINE OF LATHES

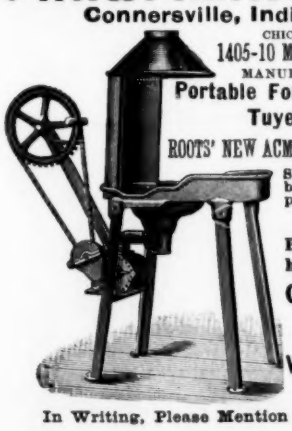
48-INCH SWING.

After 30 years' experience devoted exclusively to the manufacture of metal-working machinery, we are in a position TO-DAY to please the most critical, and with our improved facilities we are ready to undertake the BUILDING OF
SPECIAL MACHINES.
and many more modern made metal manipulating machinery manufactured by
FITCHBURG MACHINE WORKS, FITCHBURG, MASS.

Our Pattern and Carpenter Shops are larger than some of our friends realize. They have an area of over 6,000 square feet, and places for twenty-five workmen. The equipment is almost entirely new. We have made a great many outside patterns, and are now doing considerable of this work, but we desire to obtain more. We can promise prompt and satisfactory service, and we respectfully solicit your orders.

BUILDERS IRON FOUNDRY,
PROVIDENCE, R. I.

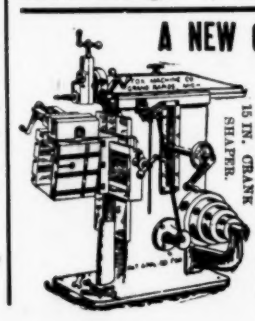
P. H. & F. M. ROOTS,
Connersville, Indiana.
CHICAGO OFFICE:
1405-10 Manhattan Building.
MANUFACTURERS OF
Portable Forges,
Tuyere Irons, Etc.
ROOTS' NEW ACME HAND BLOWERS,
Slow speeded, Force blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, Etc.
COOKE & CO.
Selling Agents,
163 and 165 Washington St.,
NEW YORK.



In Writing, Please Mention This Paper.

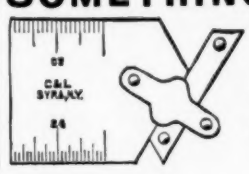
BOSTON GEAR WORKS
Frank Burgess, Prop., 35 Hartford St., Boston, Mass.
Any size or style. Spur, Bevel, Spiral, Ratchet, Worm, Rack, Elliptic, Internal, etc. Small or large. Send for Catalogue. 1,100 sizes of Gears.

A NEW CRANK SHAPER.
NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England.



QUINT'S
TURRET DRILLS
For Drilling and Tapping with from 2 to 12 Spindles.
WILL DRILL UP TO ¾-INCH.
Sensitive and Positively Driven.
A. O. QUINT, Hartford, Conn.

SOMETHING NEW!



Adjustable Notch Centre Gauge.
Price, post paid, 50 cents.
Coffin & Leighton,
SYRACUSE, N. Y.

WORTHINGTON CONDENSER.
ONLY APPARATUS that can MAINTAIN a VACUUM on ENGINES and ELEVATE the discharge WATER to TANK at any height.
This feature is appreciated by PAPER MILLS, SUGAR REFINERIES, COTTON and WOOLEN MILLS.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York,Clev'd,O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—3 H. P. engine and boiler in first-class condition. Stuart Kenelpp, Box 196, Mt. Carmel, Ill.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

For Sale—"Mod'n Mach. Shop Prac.," by J. Rose, complete, 3 vols.; new. J. G. Kingsbury, Bridgeport, Conn.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For Sale—Steam pump, almost new; send stamp for particulars. Stuart Kenelpp, Box 196, Mt. Carmel, Ill.

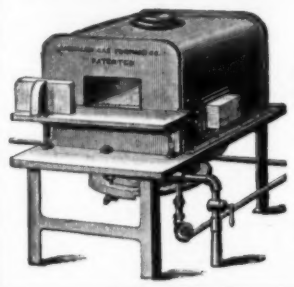
Wanted—Complete Vol. 1 (1878) American Machinist; also 1 copy each Jan. 1 & 8, 1881; must be in good condition state price. G. L. T., Am. Mach.

Would like to meet a man to engage in boiler making; office man preferred, or boiler maker; $3,000 capital; business is running at present; only one shop in the city. Address Box 142, American Machinist.

Introduction and negotiation of Americanpatents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.

Partnership wanted in a paying established business by an experienced and successful mechanical engineer and manager who can invest in ready cash and devote his entire time to the business; no objection to joining with a good business man with corresponding capital in pushing a safe and profitable enterprise. Address with full particulars, Engineering Partner, American Machinist.

Wanted—Second-hand machinery. Must be in good order. One Adt automatic wire straightening and cutting machine for No. 5 wire, 5 ft. lengths; one screw cutting engine lathe, 30 in. swing, about 12 ft. bed; one Hendey shaper, 24 in. stroke; one 2,000 lb. belt power freight elevator; 96 ft. 3 in. cold rolled shafting, 20 or 24 ft. lengths, with compression couplings; ten ball and socket 3 in. hangers, 24 in. drop. Address Lock Box 501, New Orleans, La.



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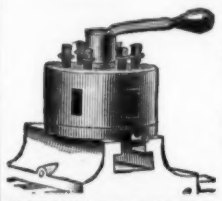

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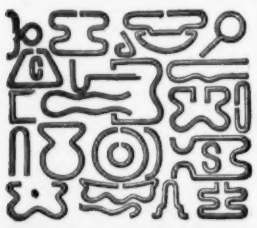

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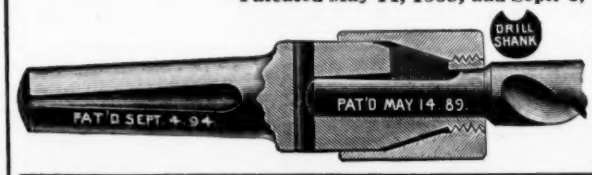

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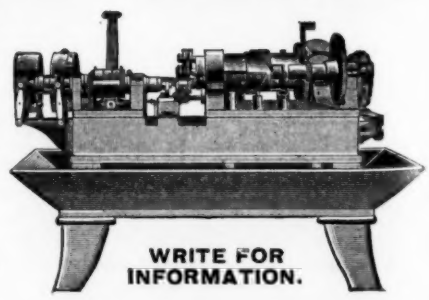

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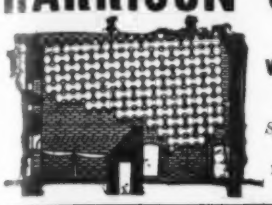

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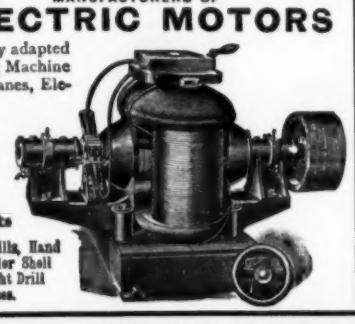

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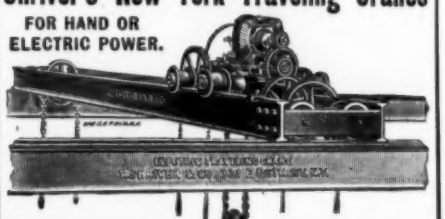

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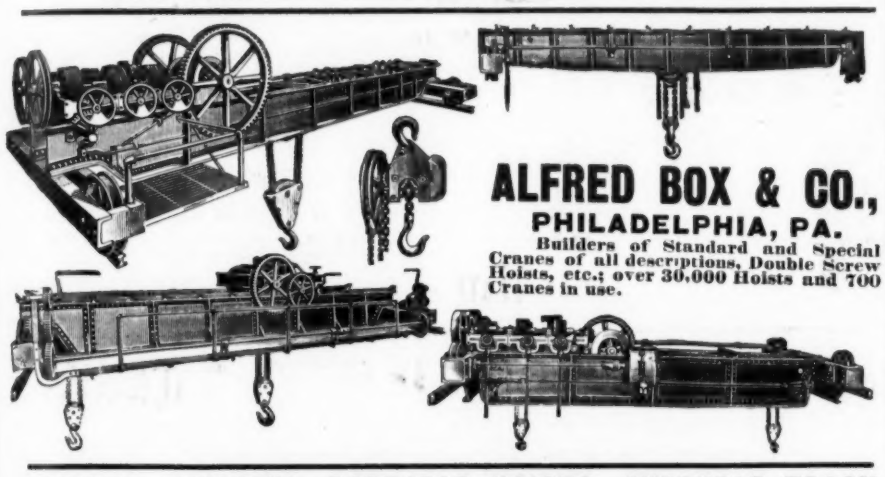

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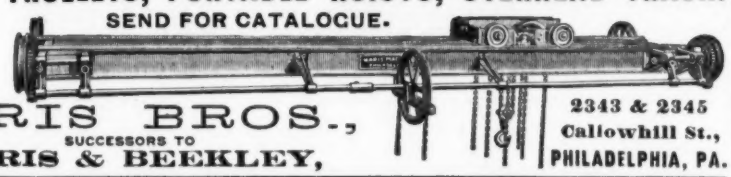

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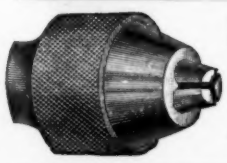

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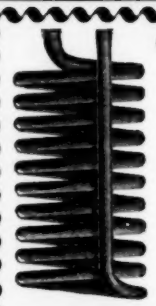

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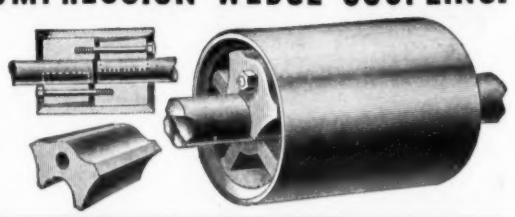

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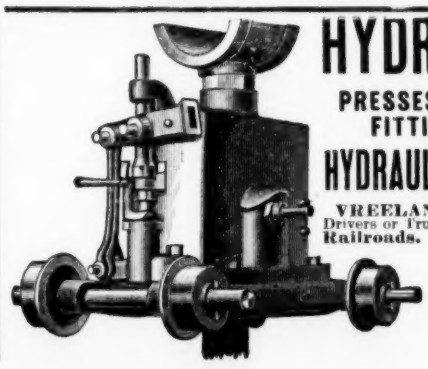

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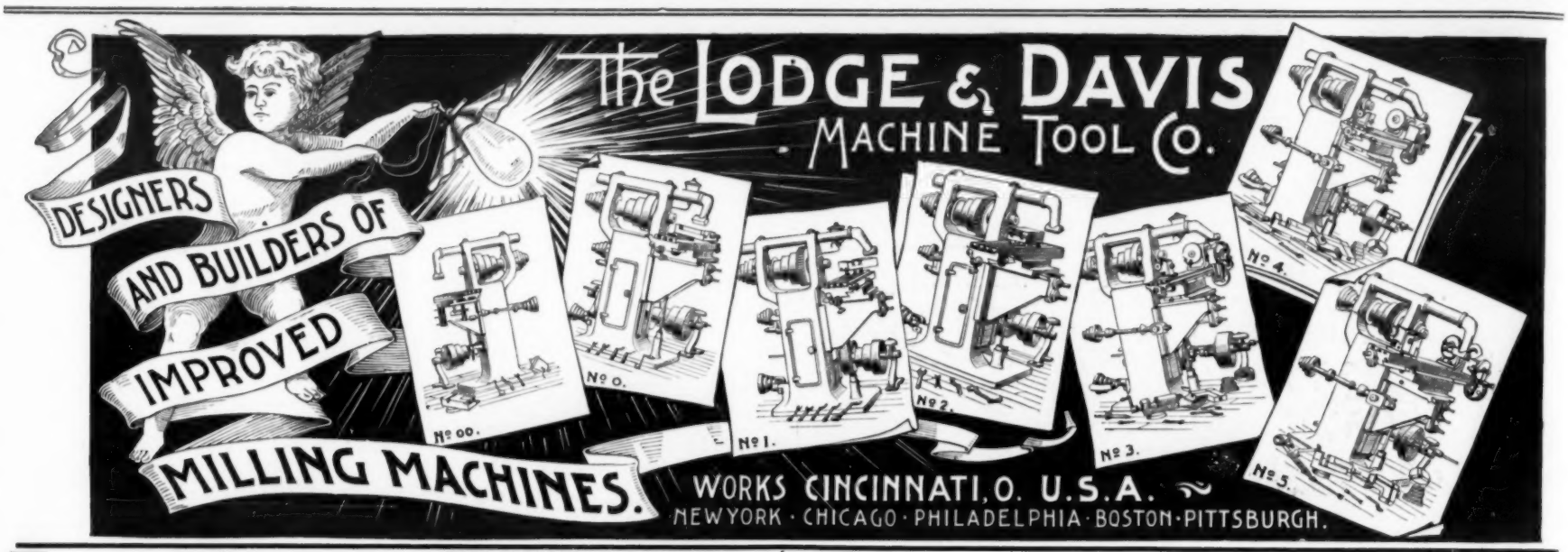

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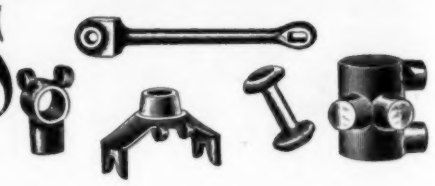

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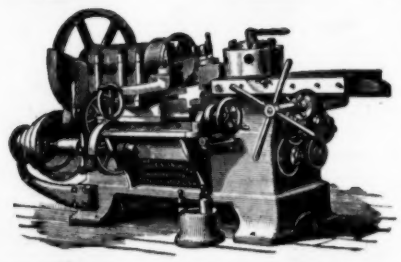

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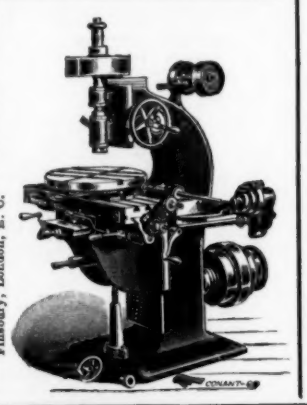

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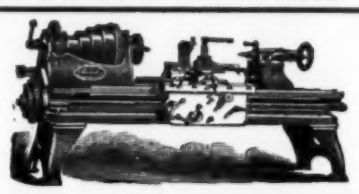

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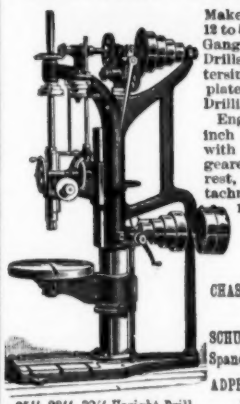

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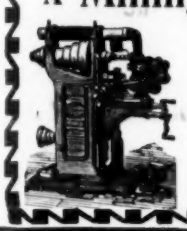

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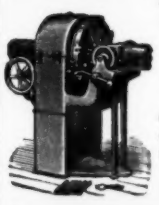

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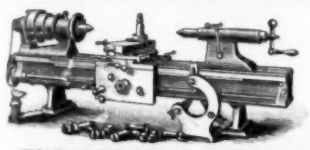

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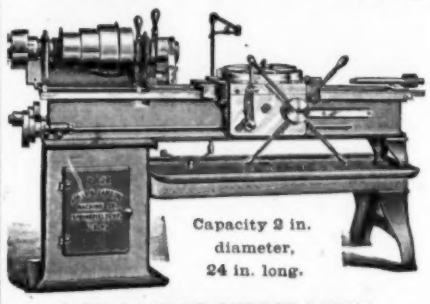

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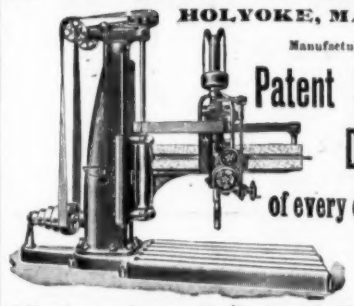

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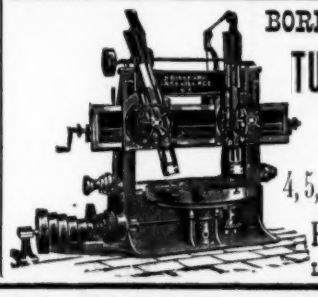

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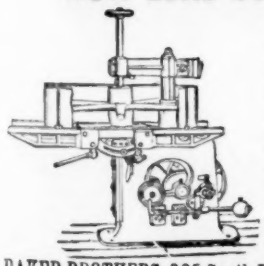

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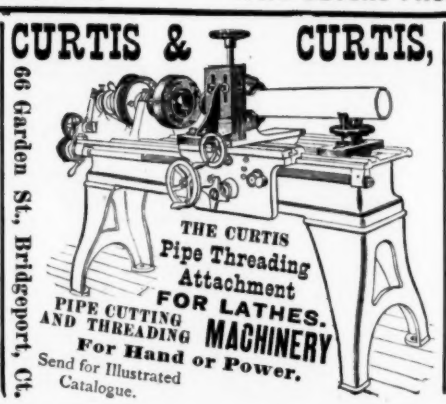

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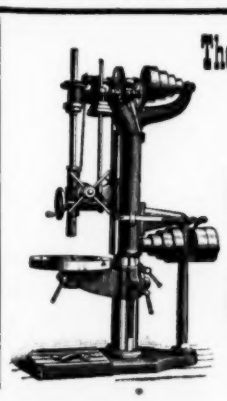

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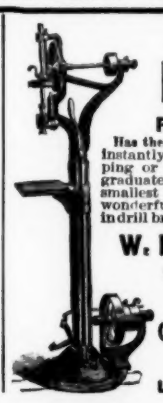

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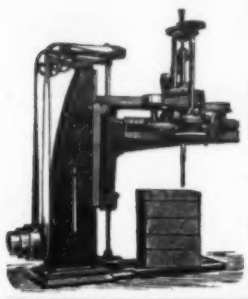

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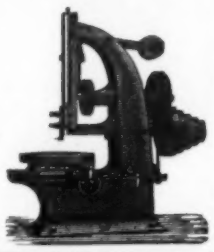

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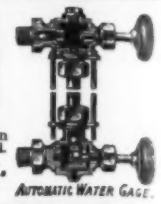
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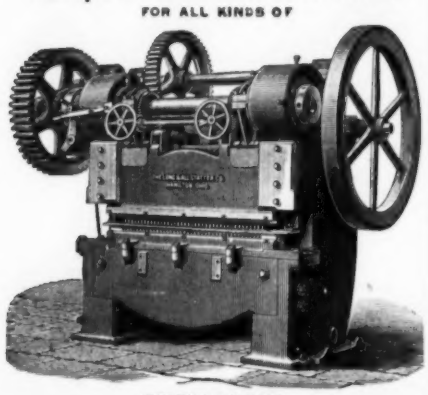
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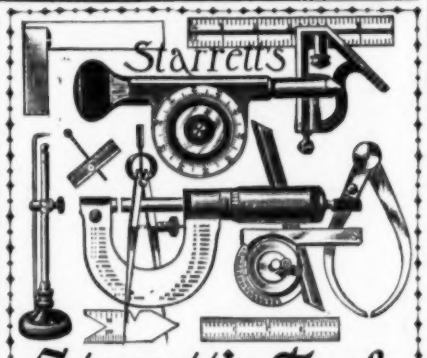

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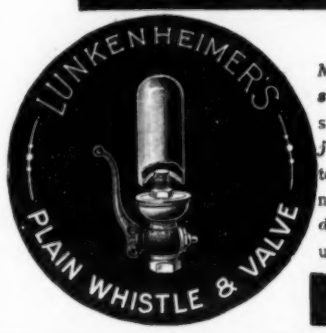

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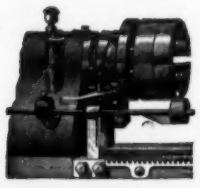

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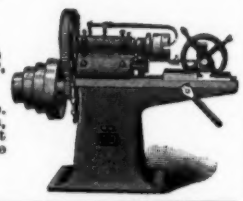

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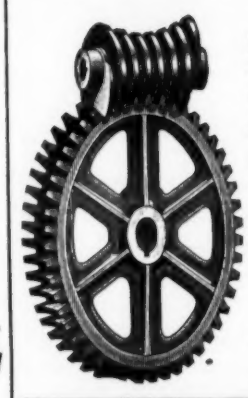

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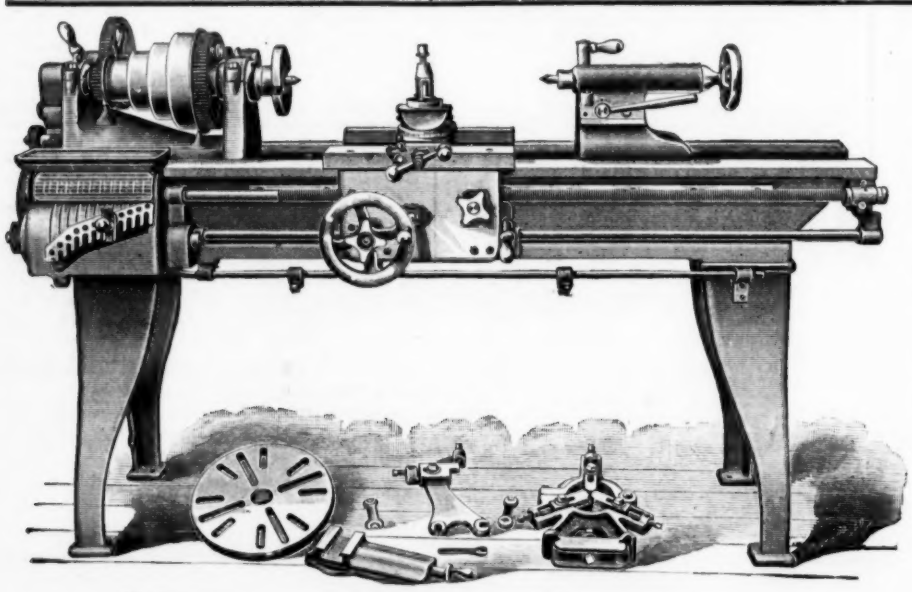

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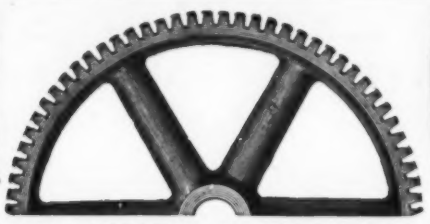

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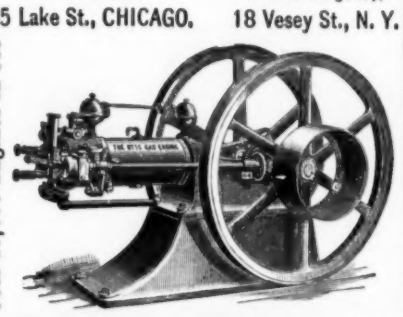

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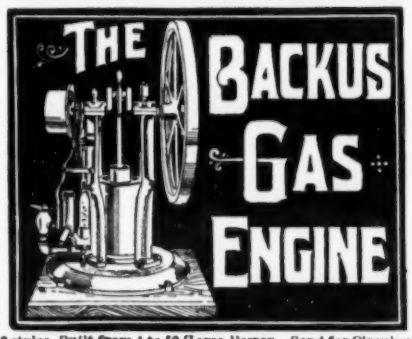

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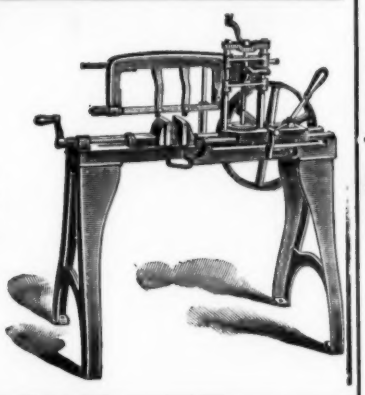

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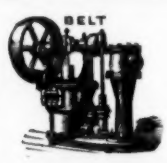

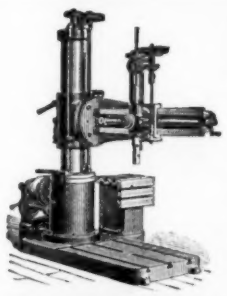

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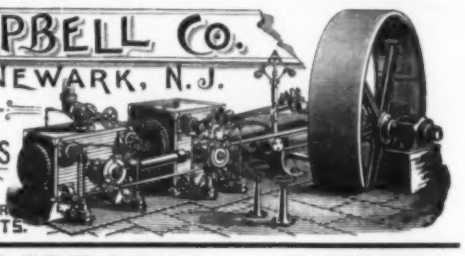

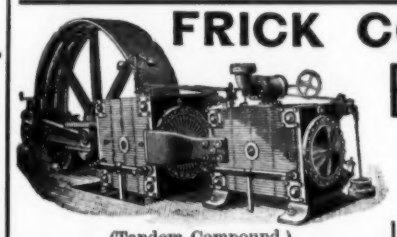

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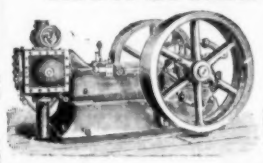

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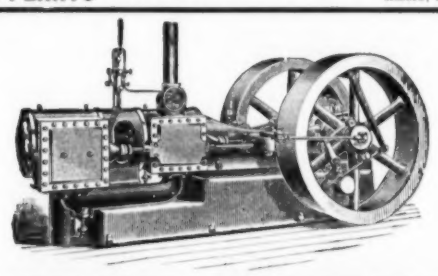

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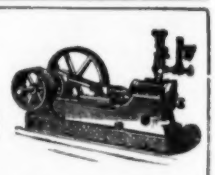

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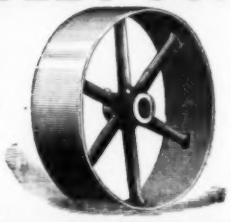

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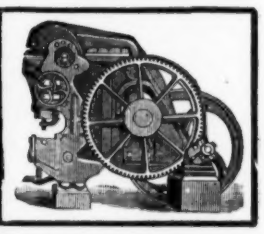

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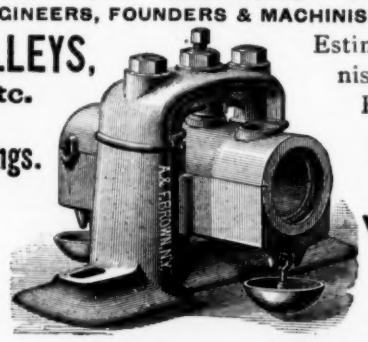

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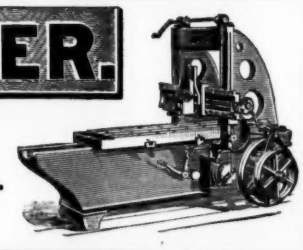

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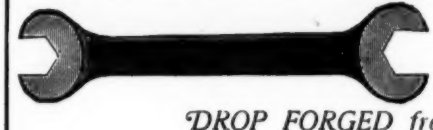

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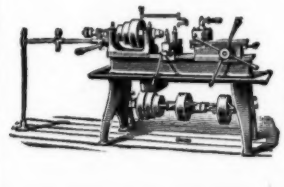

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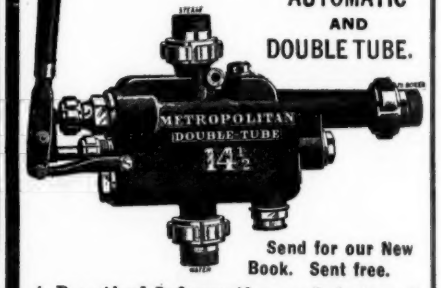

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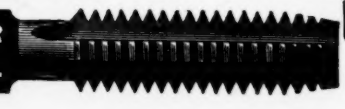

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